Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

APRIL, 1951

TECHNOLOGY DEPT.

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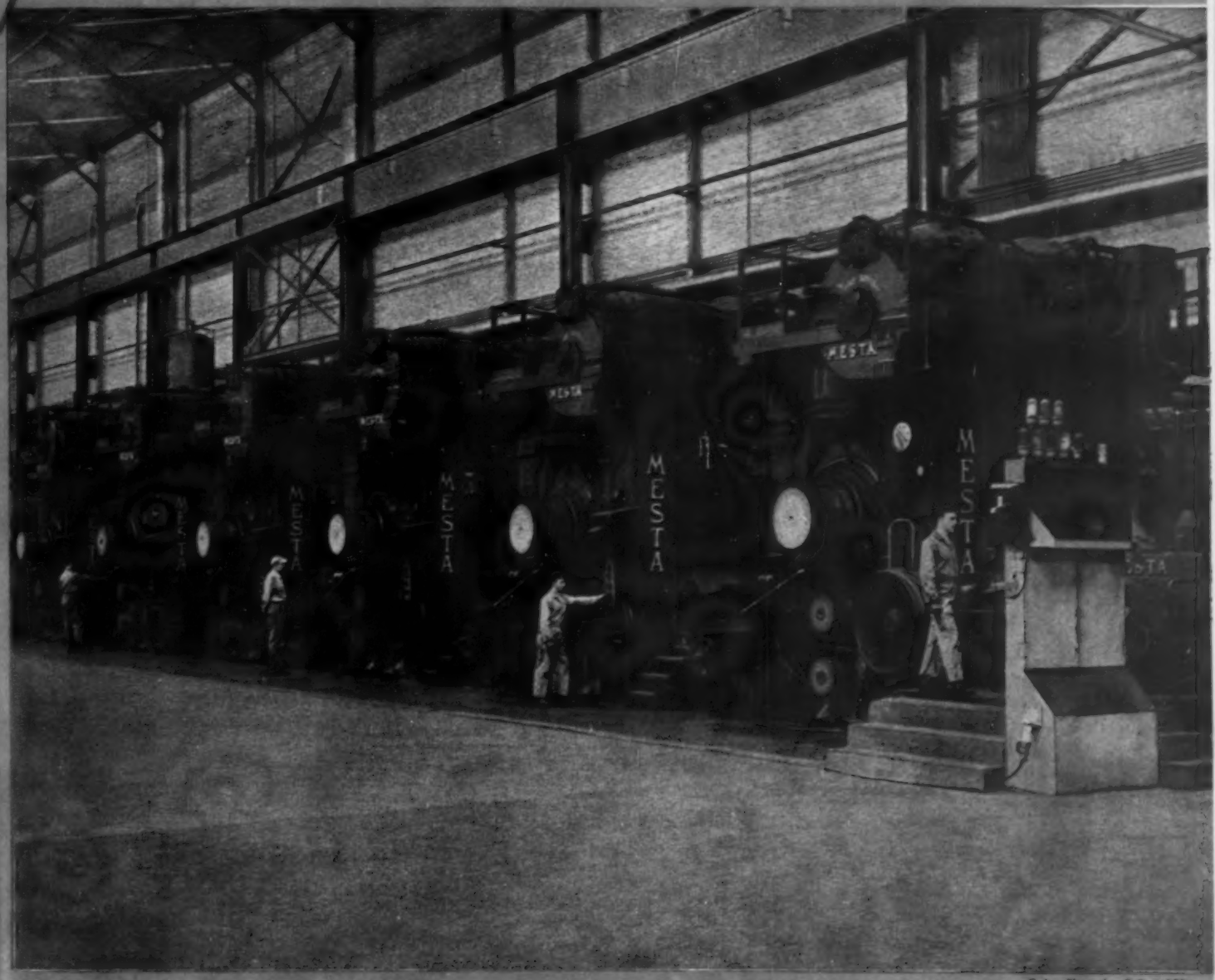
MAY 16 1951

HOT STRIP MILLS
. . . designed and built by

MESTA



Color Photo by E. D. MESTA

Mesta 68" Four-High Continuous Hot Strip Mill Finishing Stands

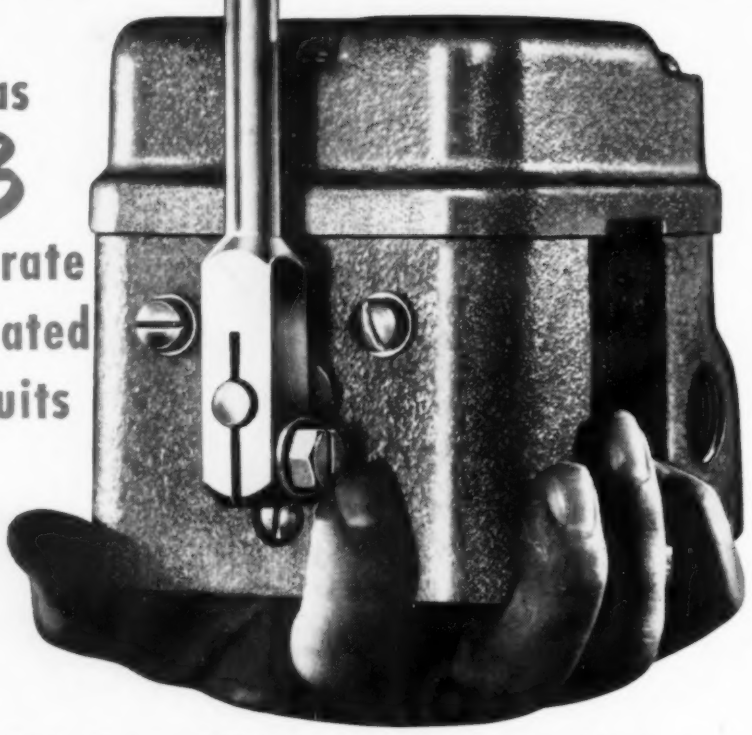
DESIGNERS AND BUILDERS OF COMPLETE STEEL PLANTS

MESTA MACHINE COMPANY • PITTSBURGH, PA.

New Cam Operated

MILL ACCESSORY MASTER

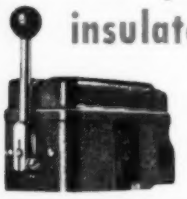
Has 3 separate insulated circuits



"FIVE BY FIVE"

Actual size of case
5½ x 5¼ x 5½

Also in 6 separate insulated circuits



Case measures 5½ x 5¼ x 8⅛

The new Cutler-Hammer Mill Accessory Master has been designed for the many steel mill applications where a cam operated type master switch of very small dimensions is required. This new small master is available with either 3 or 6 separate insulated circuits; cast iron case for surface mounting and in skeleton or sheet metal case for back-of-panel or bench-board flush mounting.

Five standard models are available for these usual types of magnetic controllers:

1. Single speed reversing without low voltage protection in the 3 circuit master.
2. Single speed reversing with low voltage protection in the 3 circuit master.
3. Two speed reversing without low voltage protection in the 3 circuit master.
4. Two speed non-reversing with low voltage protection in the 3 circuit master.
5. Single or two speed non-reversing or reversing with or without low voltage protection in the 6 circuit master.

In addition, both the 3 circuit and 6 circuit master may be had with "daisy-petal" twist-off cam elements adaptable to special circuit requirements . . . which enable you to stock a supply of these masters and tailor each to the requirements of each application.

The switch is provided with double break bridging contacts, molded arc-resistant arcing chambers. The switch has positive star wheel action with readily adjustable star wheel tension. Star wheel cam and roller, and switch cams and rollers, are case hardened. The cam shaft is mounted on self-aligning ball bearings. Handle can also be furnished as self-centering from either or both directions. The clamp-on type handle is readily adjustable to any angular position. The cast iron case of the surface type enclosure has conduit openings in both sides and one in the bottom. The switch is easy to wire, with solderless type lugs; each terminal is arranged for two wires. Rugged construction assures low maintenance. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

where can YOU use

this new mill accessory master?

HERE ARE BUT A FEW OF MANY PRESENT USES:

Blowers	Lifts	Pickling Tanks
Conveyors	Saws	
Electric Heaters	Machine Tools	Sizing Mills
Kick-offs	Mandrel Extractors	Solenoid Valves
Levelers		

A pair of pliers does the trick!

When You Tailor This Master To The Job

When there are special circuit requirements to be met, both the 3 circuit and 6 circuit masters are available with "daisy-petal" twist-off cam elements which can be "tailored" to the needs of the specific job. Petals can be twisted off with a pair of pliers to form any cam arrangement.

CUTLER-HAMMER
MOTOR CONTROL
C-H

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 28, No. 4.

aetna-standard makes the mills which make seamless tubing

aetna-standard

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Plants in Warren, Ohio · Ellwood City, Pennsylvania

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Aetna-Standard Engineering Company, Ltd., Toronto, Ontario, Canada.

M. Castellvi, Inc., New York, N. Y.—Mexico, Central and South America

Societe de Constructions de Montbard, Paris, France—France, Belgium, Holland, Luxembourg, Switzerland.

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Aetna-Japan Company, Ltd., Tokyo, Japan Japan.

Hale & Kullgren, Inc., Akron, Ohio Representative for the Rubber Industry.

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Whatever type
rolls you need in forming
shapes, National has the facilities
and the experience to produce them *right*
for the job.
You can depend on them to help you maintain uninterrupted production schedules.
Their quality-controlled casting, built-in strength and accurate finishing
assure you longer tonnage
life in the stands.

THE NATIONAL ROLL & FOUNDRY CO.
Avonmore, Pennsylvania
Specialists in Iron and Alloy Iron Rolls and Castings

THE INSIDE STORY OF . . . BETTER GEAR PROTECTION

with TEXACO MEROPA LUBRICANTS

Extreme pressures generated in enclosed reduction gear drives and pinion stands call for a lubricant that's tough . . . one that's good "in the squeeze" . . . *Texaco Meropa Lubricants!* These oils are designed to prevent metal-to-metal tooth contact under highest pressures. Result — smoother, quieter operation, full protection and longer life for gears and bearings, and lower maintenance costs.

Texaco Meropa Lubricants are especially resistant to oxidation and thickening. They do not foam . . . will not separate in service, storage or centrifuging . . . protect bearings from corrosion.

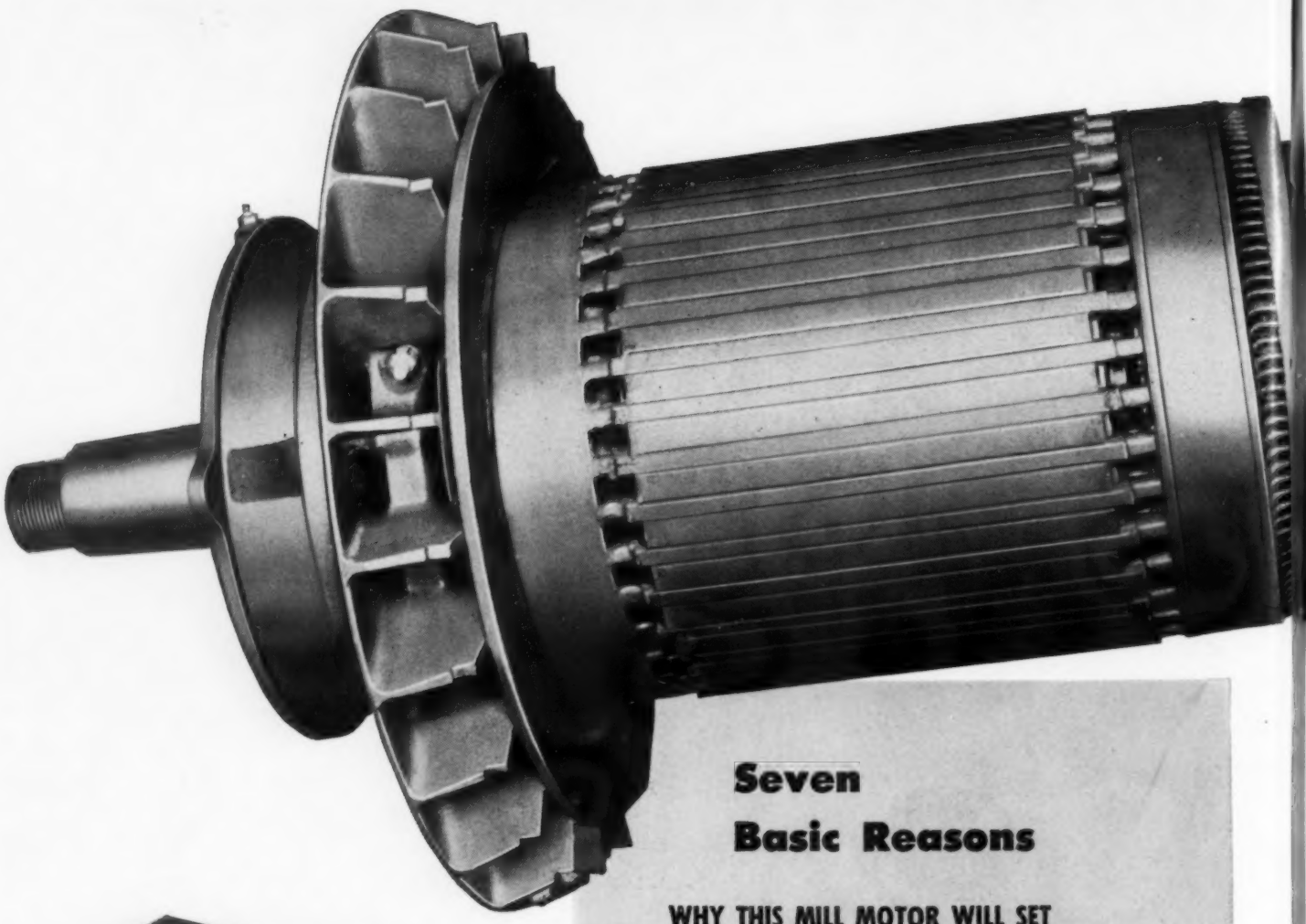
For further economies and protection for oil film roll necks, use *Texaco Regal Oils.* These heavy-duty, turbine-grade oils resist oxidation, emulsification and sludging. They keep systems clean, bearings protected.

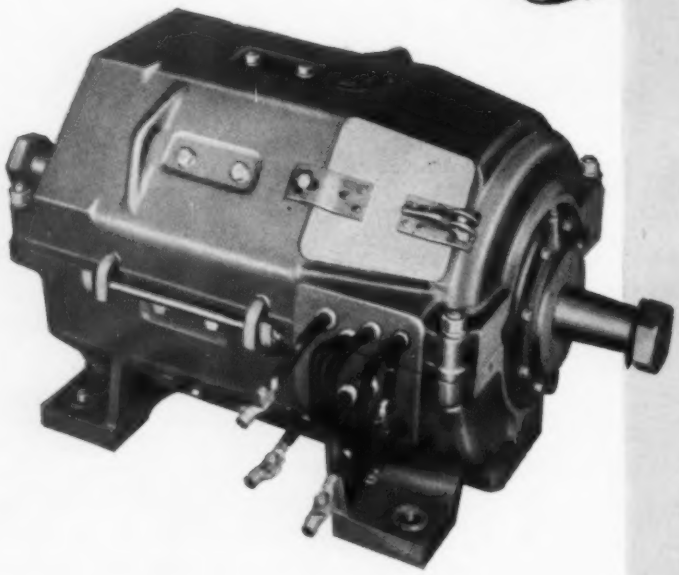
A Texaco Lubrication Engineer will gladly help you select the proper lubricants for savings throughout your mill. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Meropa Lubricants
FOR STEEL MILL GEAR DRIVES

TUNE IN . . . TEXACO STAR THEATER starring MILTON BERLE on television every Tuesday night. See newspaper for time and station.





Seven Basic Reasons

WHY THIS MILL MOTOR WILL SET NEW STANDARDS OF PERFORMANCE IN YOUR PLANT

1. BETTER COMMUTATION: Brushes with ample current-carrying capacity—properly designed commutator—specially shaped commutating pole faces.

2. UNIT ASSEMBLY OF FIELD COILS: Formed coil completely insulated and then assembled on a steel shell to protect coil from grounding or chafing against the pole.

3. HIGHER MAXIMUM SAFE SPEEDS: Anchoring of armature coils with individual wedges permits safe operation at higher speeds—no core bands to come loose and cause trouble.

4. HEAVIER AXLE STEEL SHAFT: Larger in diameter between the bearings, on horsepower basis—made possible by mounting punchings directly on the shaft which is removable.

5. RIGIDLY MOUNTED COMMUTATOR: Bridge construction supports each end of commutator on shaft—no overhang.

6. CAST-ALUMINUM FAN: One piece—large diameter provides a plus in cooling.

7. LOW-INERTIA ARMATURE: Allows motor to start, stop and reverse with minimum stored energy.

Look—
No Core Bands!

Wedges give you the toughest mill motor built

Wedges, instead of bands, hold the armature coils firmly in place on the new Westinghouse Series 600 Mill Motor. This means a stronger armature that is capable of safe operation at higher speeds . . . increased motor efficiency.

Broken core bands are destructive, also core bands can cause damage to the insulation on armature coils during assembly. Wedges eliminate this risk—make winding a simple operation. Each slot has its own individual wedge . . . made of Class B material. Simplifies servicing and repair work.

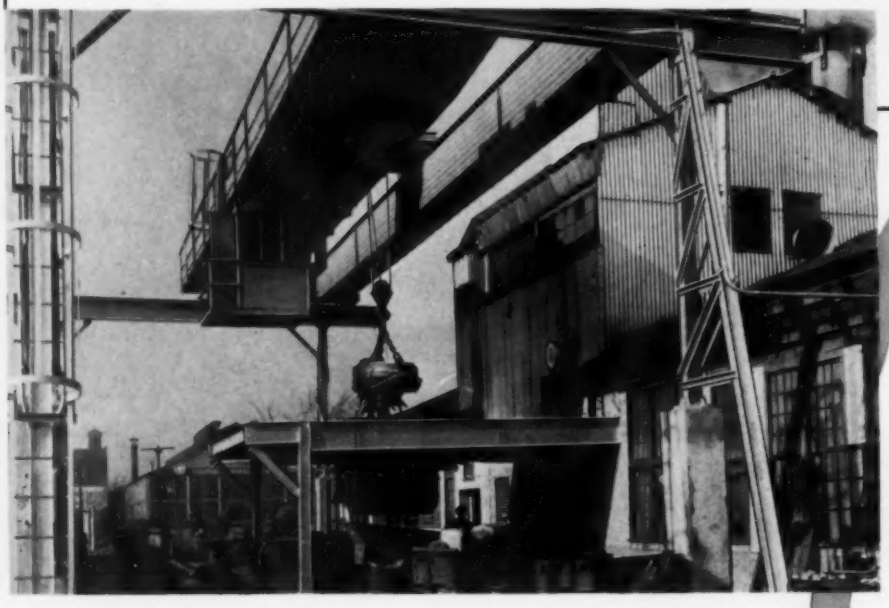
Further, complete insulation of the armature provides maximum electrical strength. Mica wrapper and glass tape protect the conductor. Complete armature assembly is impregnated with thermoset varnish. All this adds up to a rugged armature for a strong motor—built to handle your toughest jobs.

There are many more advantages offered by this mill motor that you will want to consider. Your Westinghouse representative has all the facts. Ask him for your copy of Booklet B-4730. Or write direct to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21646

YOU CAN BE SURE.. IF IT'S
Westinghouse

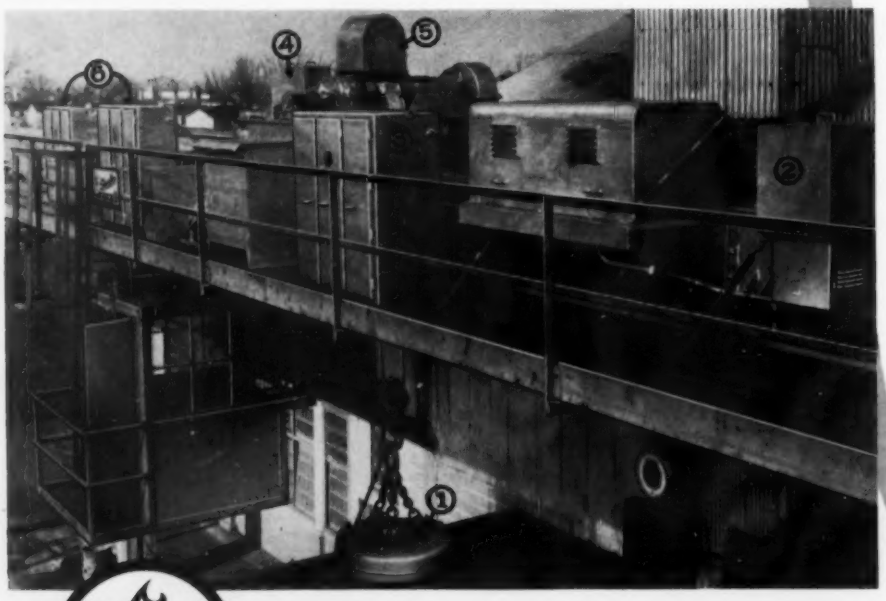
MILL MOTORS
AND CONTROLS

WHEN BUYING MAGNET CRANES SPECIFY EC&M CONTROL AND MAGNETS



EC & M Control is a complete line and built to meet all requirements—short or tall controllers to suit headroom—standard or under-lever master switches for front or rear of cage mounting—accelerating, plugging and speed-limiting systems of control that result in simplicity and safe operation. Control—the vital small cost of a crane. Specify EC & M Control.

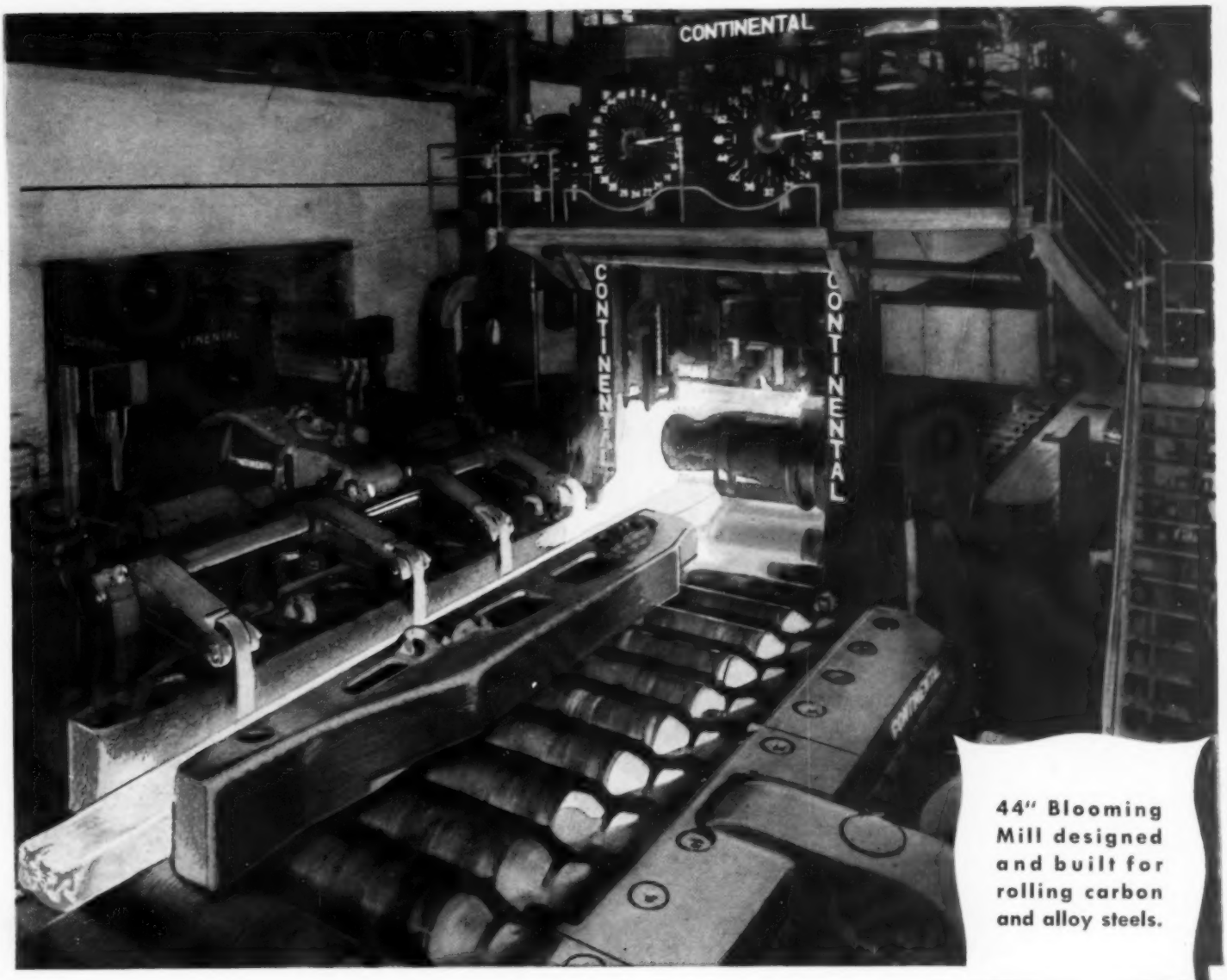
THESE PRODUCTS IMPROVE CRANE PERFORMANCE IN MANY WAYS



KEY TO EC&M UNITS SHOWN IN ILLUSTRATIONS

1. All-Welded Lifting Magnet
2. Automatic Discharge Magnet Controller
3. Contra-Torque Hoist Controller
4. Type WB Brake
5. Youngstown Safety Crane-Hoist Limit Stop
6. Frequency Relay Controllers for Bridge and Trolley Motions

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO



44" Blooming Mill designed and built for rolling carbon and alloy steels.

Blooming and Slabbing Mills

ROLLING MILLS

Designers and producers of complete mill installations and auxiliary equipment.

ROLLS

Iron, Alloy Iron and Steel; for all types of rolling mills.

CASTINGS

Carbon and Alloy Steel, ranging from 20 to 250,000 lbs.

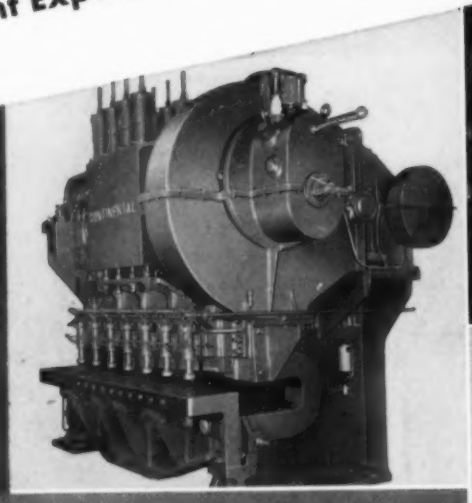
Continental

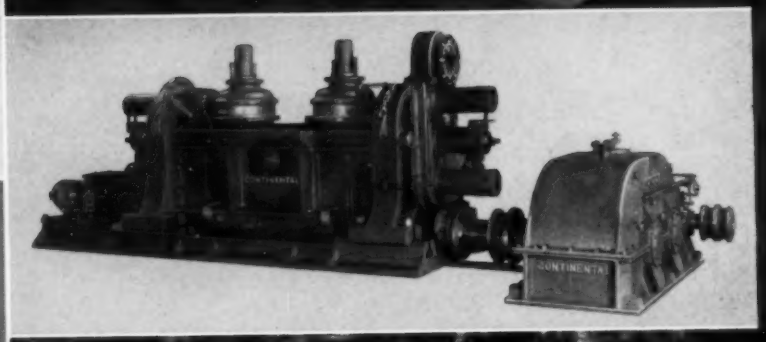
Continental
FOUNDRY & MACHINE CO.
CHICAGO • PITTSBURGH
Plants at East Chicago, Ind., Wheeling, W. Va., Pittsburgh, Pa.

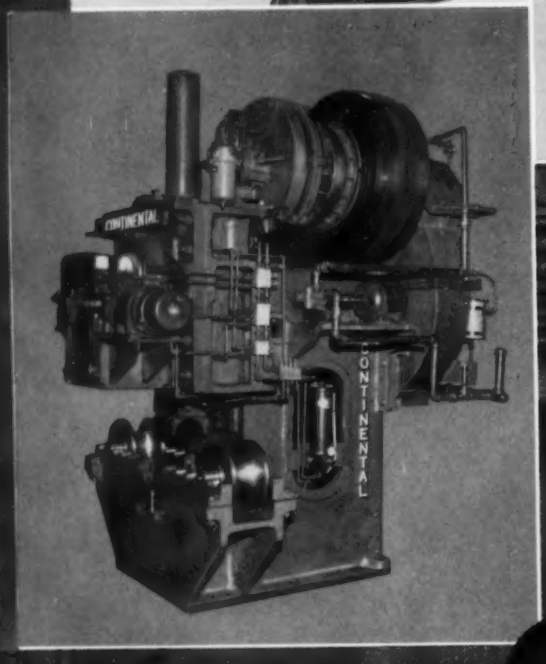
A Specialty!

STEEL PLANT EQUIPMENT

Custom Engineered for Steel Plant Expansion and Modernization







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Continental

CHICAGO • PITTSBURGH

CASTINGS: Carbon and Alloy Steel from 20 to 250,000 Pounds.
ROLLS: Iron, Alloy Iron and Steel; for All Types of Rolling Mills.
MILLS: Complete Installations of Rolling Mills and Auxiliary Equipment.

Yes, We build WIRE ROD MILLS

AMERICAN WIRE CO.	Cleveland, Ohio	1888
GRAND CROSSING TACK CO.	Chicago, Ill.	1899
SHARON STEEL CO.	Sharon, Pa.	1901
SHARON STEEL CO.	Sharon, Pa.	1901
WICKWIRE BROS.	Cortland, N. Y.	1901
DOMINION IRON & STEEL CO.	Sydney, N. S.	1903
J. MOUTON	Paris, France	1903
MORGAN SPRING CO.	Struthers, Ohio	1905
SOC. ANON. D'OUGREE-MARIHAYE	Ougree, Belgium	1906
ALPINE MONTAN GESELLSCHAFT	Vienna, Austria	1907
PITTSBURGH STEEL CO.	Monessen, Pa.	1908
JONES & LAUGHLIN STEEL CO.	Aliquippa, Pa.	1909
CAMBRIA STEEL COMPANY	Johnstown, Pa.	1909
DOMINION IRON & STEEL CO.*	Sydney, N. S.	1910
JONES & LAUGHLIN STEEL CO.	Aliquippa, Pa.	1911
STEEL CO. OF CANADA, LTD.*	Hamilton, Ont.	1912
BROKEN HILL PROPRIETARY CO.	Newcastle, Australia	1915
WICKWIRE STEEL CO.	Buffalo, N. Y.	1916
KEYSTONE STEEL & WIRE CO.	Peoria, Ill.	1916
TEMPLEBOROUGH ROLLING MILLS, LTD.	Rotherham, England	1916
ACIERIES DE LONGWY	Mont-St. Martin, France	1919
WHITAKER-GLESSNER CO.	Portsmouth, Ohio	1921
BETHLEHEM STEEL & WIRE CO.	Sparrows Point, Md.	1924
AMERICAN STEEL & WIRE CO.	Worcester, Mass.	1925
JOHN A. ROEBLING'S SONS CO.	Trenton, N. J.	1927
SHEFFIELD STEEL CORP.*	Kansas City, Mo.	1928
LANCASHIRE STEEL CORPORATION*	Irlam, England	1932
GUEST, KEEN, NETTLEFOLDS, LTD.	Cardiff, Wales	1934
LACLEDE STEEL COMPANY	Alton, Illinois	1935
AMTORG TRADING CORPORATION	Makeevka, Russia	1936
BETHLEHEM STEEL COMPANY*	Sparrows Point, Md.	1936
BETHLEHEM STEEL COMPANY	Sparrows, Point, Md.	1939
COLUMBIA STEEL CO.	Pittsburg, Cal.	1941
LACLEDE STEEL CO.	Alton, Ill.	1945
BETHLEHEM STEEL CO.*	Los Angeles, Cal.	1946
NEDERLANDSCHE KABELFABRIEK	Alblasserdam, Holland	1946
GUEST, KEEN, NETTLEFOLDS, LTD.	Cardiff, Wales	1947
COLORADO FUEL & IRON CORP.	Pueblo, Colo.	1947
SOC. MINIERE ET METALURGIQUE DE RODANGE	Rodange, Luxemburg	1948
DOMNARFVETS JERNVERK**	Domnarvet, Sweden	1948
LANCASHIRE STEEL CORP.*	Warrington, England	1948
ILVA ALTI FORNI e ACCIAIERIE d'ITALIA*	Bagnoli, Italy	1949

*Mill also rolls merchant bar
**Mill also rolls merchant bar and strip

MORGAN CONSTRUCTION CO.
WORCESTER, MASSACHUSETTS

Rolling Mills - Morgoil Bearings - Wire Mills
Regenerative Furnace Control - Gas Producers - Air Ejectors

English Representative: International Construction Company
56 Kingsway, London, W.C. 2, England

RM-84

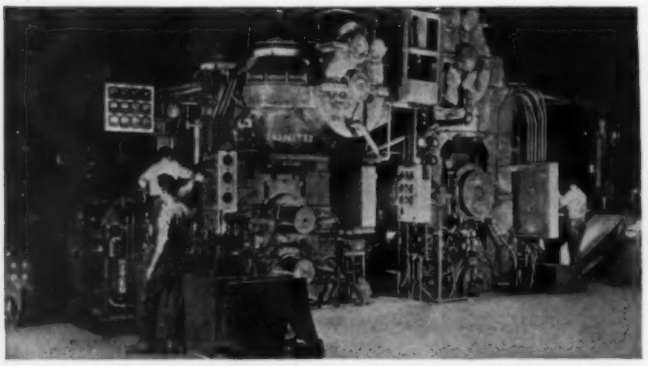
G-E drive holds accurate tension on world's fastest temper mill!

Teams up G-E amplidyne regulators with sensitive G-E regulating tensiometer to maintain uniformity and quality of steel strip—at 5000 fpm!

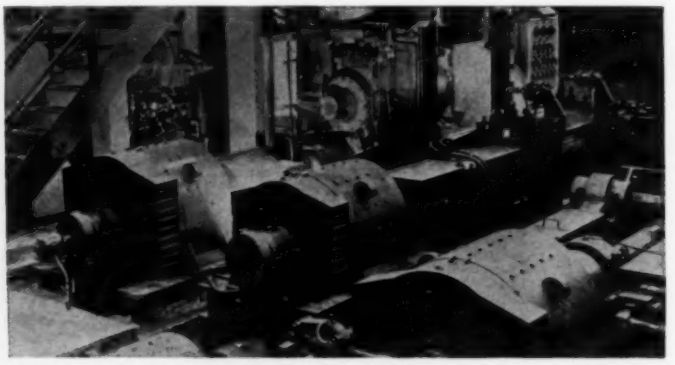
Almost a mile a minute! That's the record speed of this new two-stand temper pass cold strip mill, electrically engineered and equipped throughout as a unit by General Electric. Designed for greater steel output, this fastest mill of its kind benefits from such important features as these:

• **Full-range amplidyne tension regulators between stands and pullers, and pullers and reels, automatically compensate for all roll-diameter combinations, eliminating operator adjustments, simplifying operation.** • **Fast-acting, sensitive regulating tensiometer automatically maintains accurate tension between stands regardless of rolling-load distribution, helps assure uniform steel quality.** • **Individual-motor drive allows low-maintenance mechanical simplicity, reduces drive inertia for faster acceleration and deceleration, increased production.**

Here is further proof that G-E can handle successfully *any* steel-mill drive problem—including *yours.* Ask the G-E steel-mill specialist in your area to talk it over with your engineers. *General Electric Company, Schenectady 5, N. Y.*



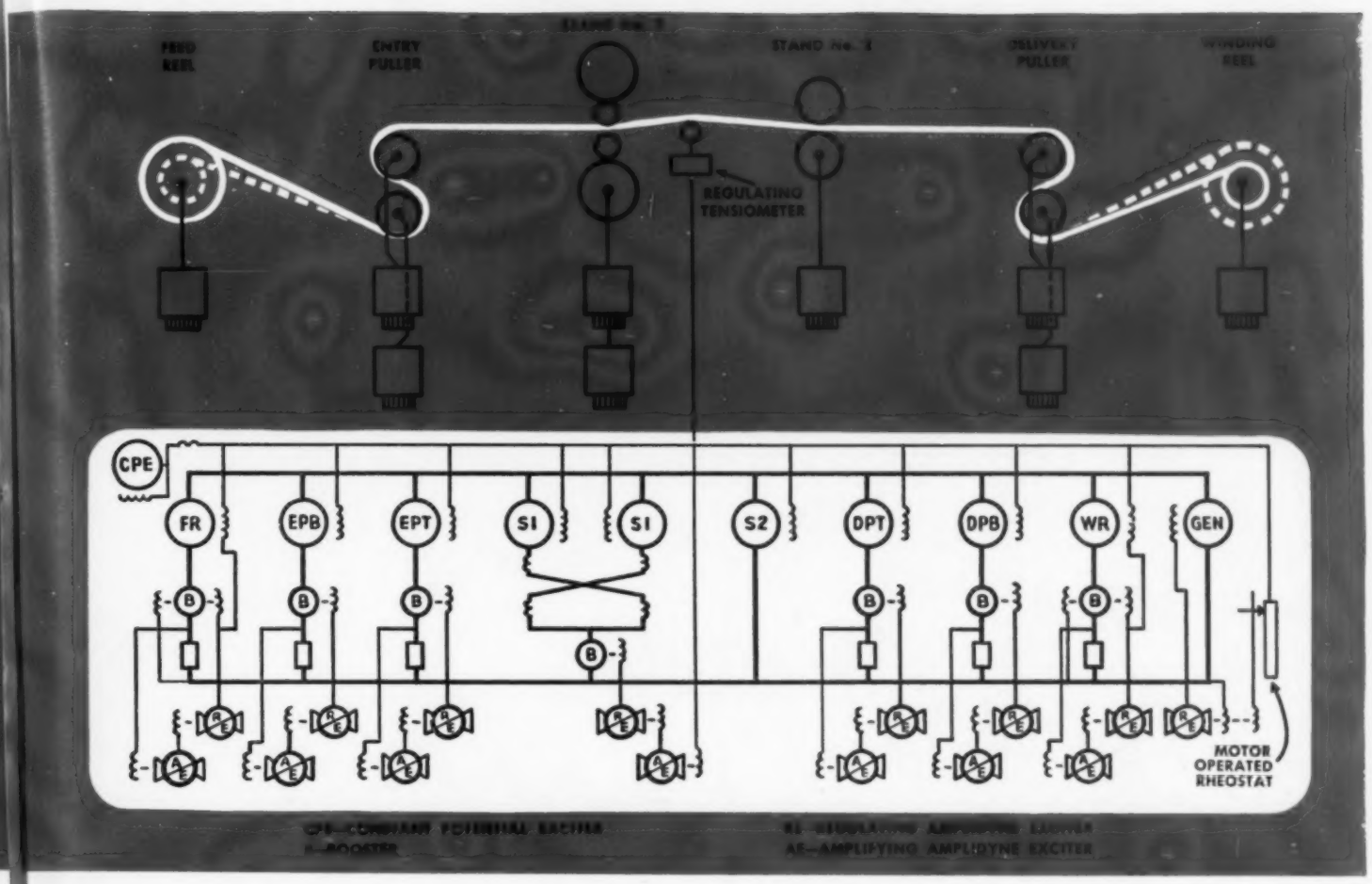
All electric equipment for this 5000-fpm temper mill—switchgear, motor-generator sets, drive and auxiliary motors, control, and ventilation apparatus—was engineered and supplied by General Electric, with G-E steel-mill specialists also helping on installation and tune-up.



Rear view shows four of the mill's 9 G-E 600-volt d-c drive motors (left to right): Stand No. 2 600-hp motor, two twin-drive 400-hp delivery puller motors, and 400-hp winding-reel motor. Extra-tough, these G-E motors, designed for metal-rolling service, are built to last in extra-tough steel-mill duty.

GENERAL ELECTRIC

659-81

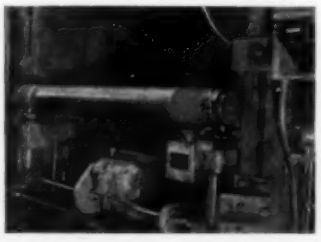


HOW THIS G-E DRIVE WORKS:

All motors are connected to a common bus supplied by a single generator. The entire mill is accelerated and decelerated by armature voltage control of the main generator, provided by a motor-operated rheostat and an amplidyne voltage regulator. Stand No. 2 motor operates directly from bus voltage and with constant field strength, so that it acts as pace-setter for all of the mill's main drive motors.

Tension reels and pullers are provided with sensitive, compensated, amplidyne current regulators which maintain accurate tension at all speeds. Tension between stands, measured by a tensiometer, is compared with a reference standard set by the operator. Any difference between the two is translated by the amplidynes into a booster voltage which acts on the Stand No. 1 motor to produce the desired value of tension.

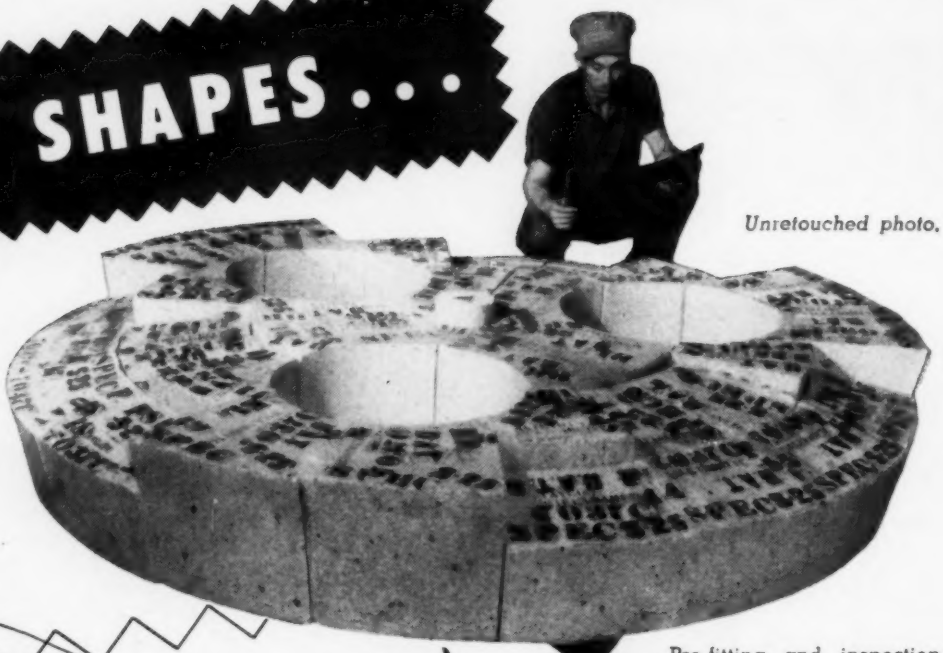
G-E regulating tensiometer helps speed up operations



An important factor in controlling the temper and flatness of the strip rolled in this mill, and in preventing strip breakage between stands, is the G-E regulating tensiometer, similar to the one shown. With a sensitivity that reacts to only 0.1 inch vertical displacement of the roll from low to high tension, it assures the fast, accurate response required—even at speeds greater than 5000 fpm. Moreover, tension is regulated continuously and to a closer degree than is possible by depending upon human judgment.

another example of
GENERAL ELECTRIC
drive engineering at work!

SPECIAL SHAPES . . .



Unretouched photo.

Pre-fitting and inspection of a Taylor Sillimanite (TASIL) Electric Furnace Roof prior to shipment from the Chas. Taylor plant.

Custom Taylored

HERE'S THE PATTERN OF *Taylor service*

1. Determine the right composition and structure to meet your service requirements.
2. Select the most efficient and economical method of forming.
3. Produce under strict control.
4. Fire in modern periodic or tunnel kilns.
5. Finish, assemble and mark to identify.

HERE'S THE RESULT *for you!*

1. A shape or complete assembly engineered for *your* job.
2. *Time saved*—pre-fitting means quick, accurate installation with minimum cutting and fitting on the job.
3. *Money saved*—through lower masonry cost; longer refractory life; uninterrupted production.

For 86 years we've been making shapes for every metallurgical need—large and small, simple and complex. Entrust your next special shape order for Taylor Sillimanite (mullite), TACOR (corundum) and Taylor Zircon to Chas. Taylor. You'll know it will be made to your specifications and satisfaction. See your *Taylor* representative.

The CHAS. TAYLOR SONS Co.

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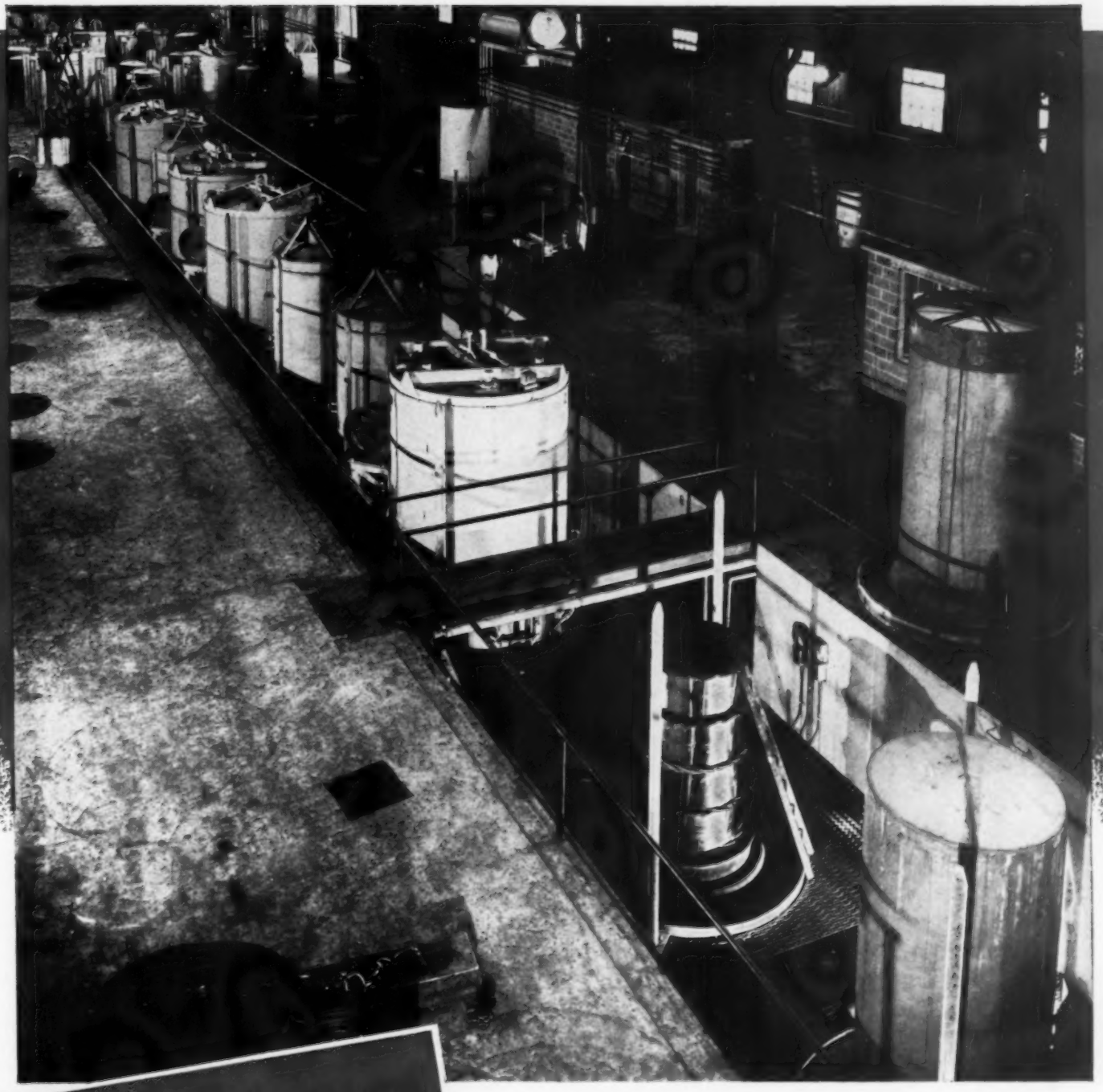
WILSON RADIANT CONVECTOR FURNACES



The new Annealing Department at the Detroit Tube and Steel Division of the Sharon Steel Corporation, Detroit, Michigan.

Lee Wilson

ENGINEERED AND CONSTRUCTED BY

ENGINEERING Co., Inc.

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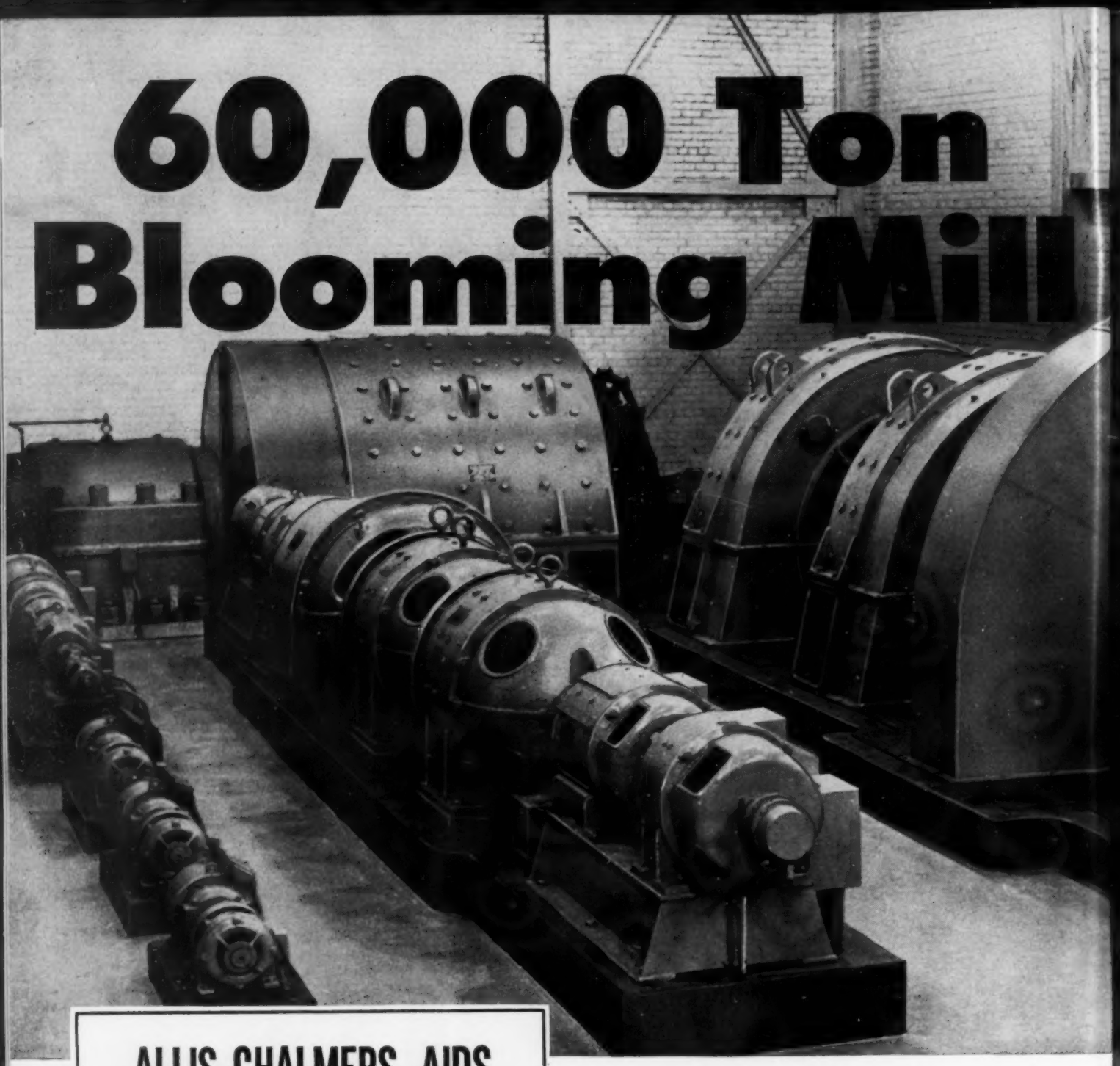
INDUSTRIAL FURNACES • RADIANT TUBE HEATING • HEAT TREATING PROCESSES

60,000 Ton Blooming Mill



ALLIS-CHALMERS AIDS EXPANSION PROGRAM AT ROTARY ELECTRIC STEEL

TODAY THE STEEL INDUSTRY FACES THE TASK of expanding while producing at a record rate. Allis-Chalmers is helping these vital expansion programs, whether they increase output by relieving one restrictive facility or by the revamping or building of an entire plant.

Rotary Electric Steel Co., Detroit, recently completed a $5 million expansion program boosting capacity over two and a half times. Melting and rolling capacity both were increased to serve better the aircraft and automotive industries.

NEW BLOOMING MILL INSTALLED

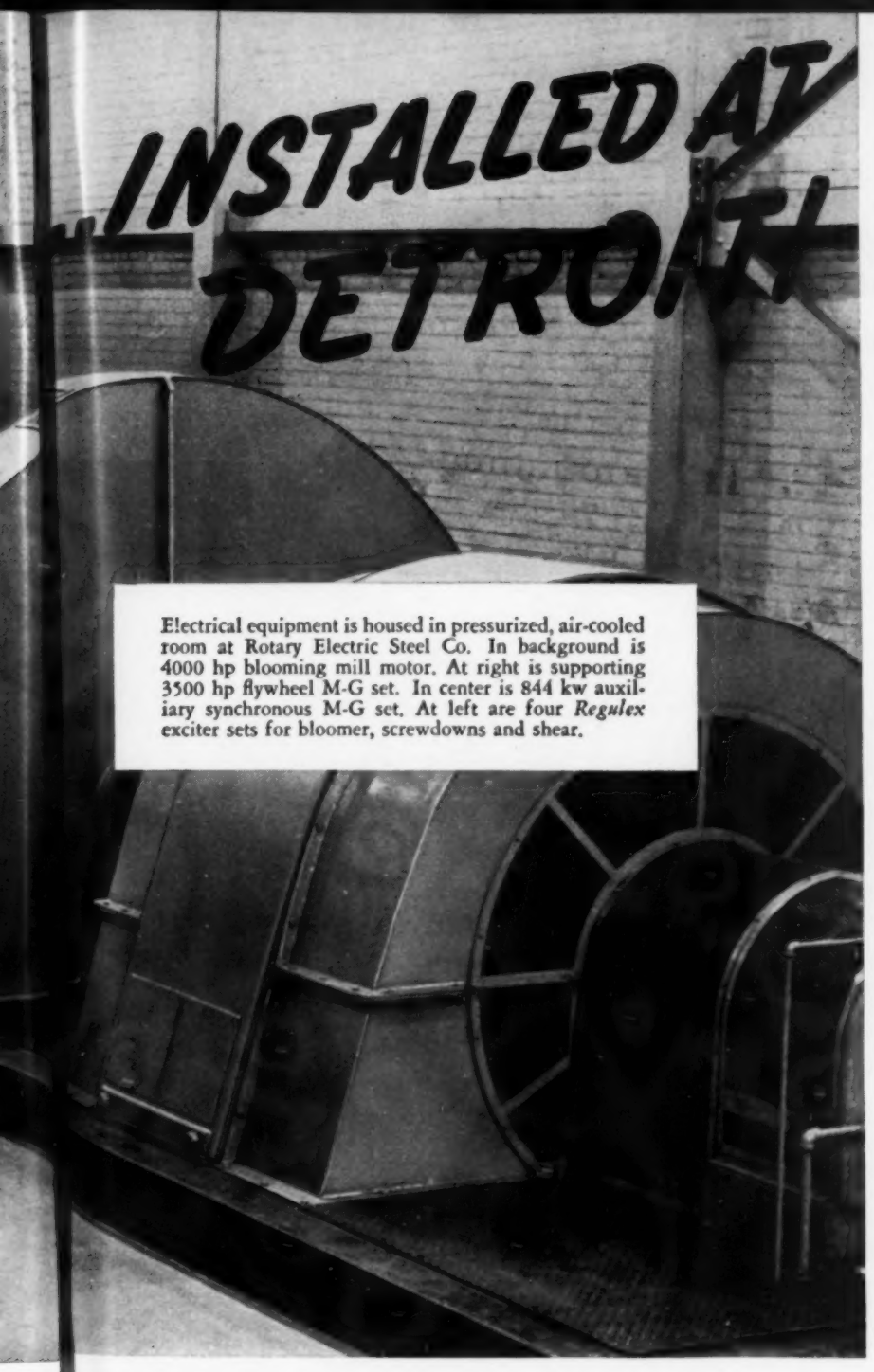
Big item in increasing rolling capacity was the installation of a 36-inch blooming mill, of 60,000 tons per month capacity, replacing the old 28-inch, 12,000 tons per month mill. The 4000 hp blooming mill motor armature is seen at right during construction. The Motor-Generator room view above shows the blooming mill motor, supporting flywheel M-G set, auxiliary synchronous M-G set, and four *Regulex* exciter sets . . . all Allis-Chalmers!

Allis-Chalmers supplied the *complete* electrical equipment

Power, Electrical, Processing Equipment for Iron and Steel

ALLIS-

INSTALLED AT DETROIT



Electrical equipment is housed in pressurized, air-cooled room at Rotary Electric Steel Co. In background is 4000 hp blooming mill motor. At right is supporting 3500 hp flywheel M-G set. In center is 844 kw auxiliary synchronous M-G set. At left are four *Regulex* exciter sets for bloomer, screwdowns and shear.

for this new blooming mill, including switchgear, liquid slip regulator, supporting M-G sets, screwdown and shear drives, and *Regulex* exciter sets. The Sach upcut shear, Allis-Chalmers powered and controlled and first of its design in the U. S., reduces waste by clean cropping. The manipulator, work table and runout table drives and controls also were supplied by Allis-Chalmers.

UNIT RESPONSIBILITY FOR PERFORMANCE

Integrated design of components and one manufacturer responsibility assure you of dependable performance. A qualified steel mill representative will give personal attention to the electrical requirements of *your* plant modernization or expansion. Offices in all major cities. A-3212

ALLIS-CHALMERS, 1020A SO. 70 ST.
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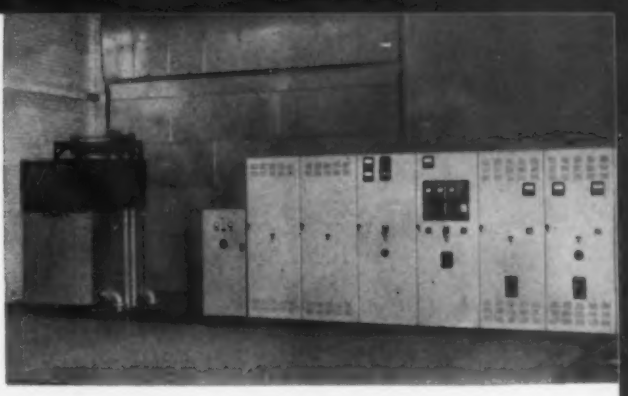
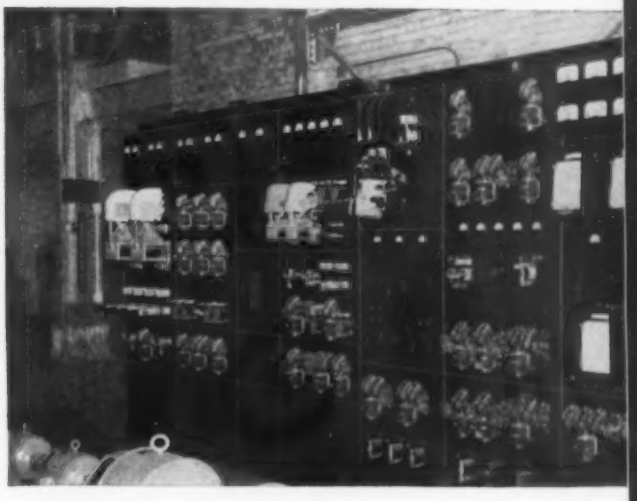


Allis-Chalmers switchgear controlling 4800 volt, three phase, 60 cycle incoming power. Exclusive 7.5 kv metal clad switchgear with drawout, vertical lift, air blast, 500,000 kva i.c. circuit breakers used here for controlling motor starting and dynamic braking. Control cubicle for liquid rheostat slip regulator at left.

Winding armature in Allis-Chalmers shops for 4000 hp blooming mill dc motor. This motor is supported by the flywheel M-G set at left. A liquid rheostat slip regulator (left, above) enables the 3500 hp flywheel M-G set motor to handle the intermittent heavy loads on the 4000 hp blooming mill reversing motor.

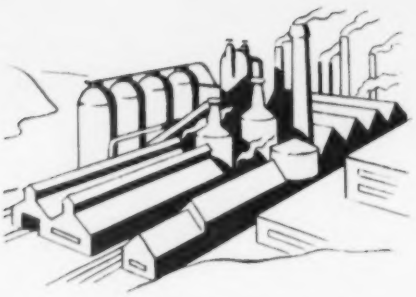


Allis-Chalmers variable voltage control board for 36-inch blooming mill and auxiliaries. From left to right: two panels for new design upcut shear, exciter panel, panel for two 75 hp screwdown motors, three panels for operation of blooming mill main drive.

Regulex is an Allis-Chalmers trademark.

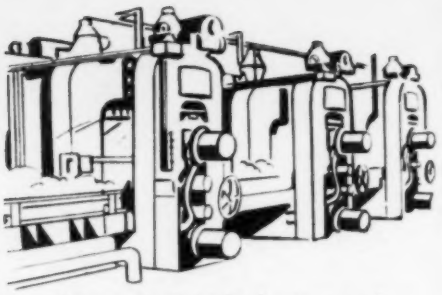
S-CHALMERS

A-C ALLIS-CHALMERS

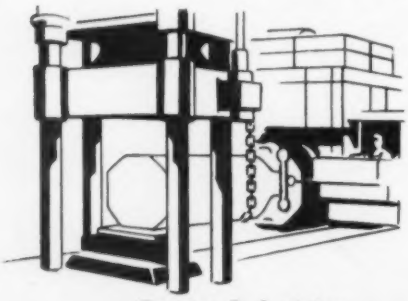


Steel Producing Plants

WHEN A *REGULAR LUBRICANT* ISN'T GOOD ENOUGH . . .



Hot Strip, Cold Reduction and Temper Pass Mills



Forging Industries

SPECIFY LEADOLENE* *Klingfast*

CHECK THESE 9 IMPORTANT FACTS:

1. **EXTREME PRESSURE pH-ilm STRENGTH** of 50,000 lbs. per square inch minimum by "Timken" testing machine.
2. **ADHESIVENESS** in which affinity for steel and other metals develops maximum adhesion and prevents drippage or creeping. Retains a flexible coating in nature.
3. **WATER REPELLENCE** which retards washing off, creates a lubricating pH-ilm under moisture or water conditions.
4. **CORROSION PREVENTION** is an excellent protective coating in that it will not etch or corrode metals. Is never acidic.
5. **COMPOUNDED STABILITY**—Will not bleed or change physical condition within range of higher than usual temperatures for this type of lubricant.
6. **LOW TEMPERATURE FACTORS**—While having a solidifying action by decreased temperature as low as —40 F., it does not harden, crack or decrease in adhesion. The flexible coating withstands distortion of the application.
7. **ABRASIVE RESISTANCE**—Extremely high for a lubricant. Does not wipe off nor will be removed in handling by workmen's hands or gloves. Is extremely repellent to adhesion of scale, metallics and other forms of dusts or contamination.
8. Klingfast has remarkable corrosive resistance to salt or sea water, acidic vapors and solutions.
9. Klingfast can be removed by ordinary solvents such as kerosene, gasolene, naphtha, carbontetrachloride and similar substances but is highly impervious to lubricating oils and greases.

The "I.P." LUBRICANT*

On the really tough jobs in the steel industry, the answer to vastly reduced lubricating costs and extended equipment life is *Leadolene Klingfast.* Capable of withstanding pressures up to 50,000 p.s.i., this lead-base lubricant with its "indestructible pH-ilm" has proved itself repeatedly on the most difficult applications.

For efficient lubrication in the presence of water . . . for extreme adhesiveness to steel under high heat conditions . . . for unexcelled abrasion and corrosion-resistance . . . for actual cash savings up to 400 per cent—investigate the performance characteristics of *Leadolene Klingfast.*

*I. P. . . . ("Indestructible pH-ilm" lubricant)

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Reclaiming of burned-out slag pots by Thermit Welding saves one major steel producer $35,000 a year.

Here, and at other plants slag pots are repaired speedily by means of Thermit, saving time and work over other methods. In addition, because they match closely the composition and characteristics of the base metal, Thermit welds stand up under the severe service conditions of alternate heating and cooling to which slag pots are subject. Re-welding at the same location is unknown . . . much longer life for reclaimed pots is assured.

Many steel mill maintenance jobs are done more easily, more quickly and at lower cost with Thermit. Investigate! Write for complete information.

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METAL & THERMIT CORPORATION

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TIMKEN® bearings in United Mill still going strong after 19 years service

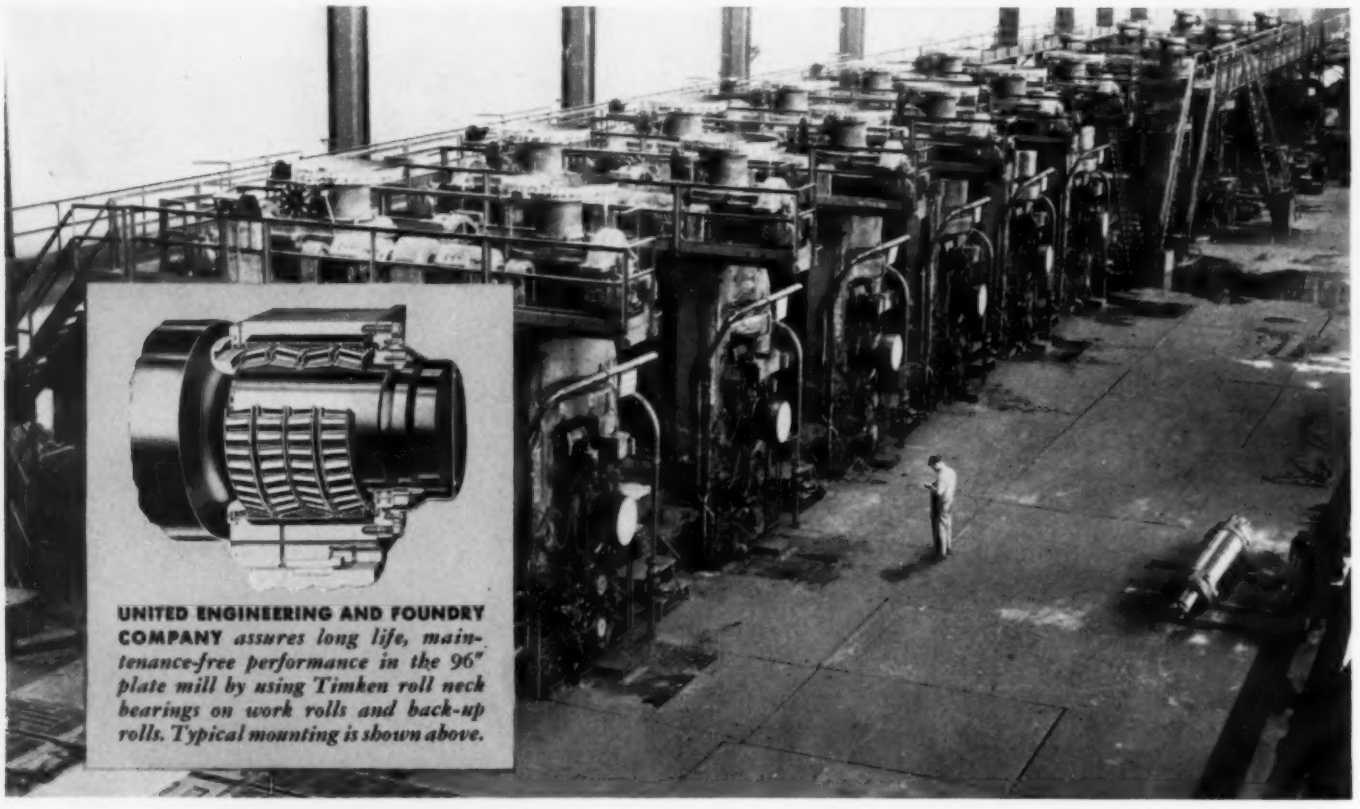
THE back-up rolls of this plate mill built by United Engineering and Foundry Company have been rolling on Timken® bearings since 1931—almost 20 years! Besides, engineers at this Chicago steel mill estimate that the 32 original Timken bearings in the mill have an average tonnage of over 3½ million tons—proof that Timken bearings are built to give long years of trouble-free service; are engineered to keep mills rolling at the lowest possible bearing cost-per-ton of steel rolled.

With balanced proportion design, Timken tapered roller bearings give you greater mill rigidity and permit larger diameter roll necks. Load rating is increased up to 40%, and roll neck strength is upped 50 to 60%.

With Timken bearings no complicated lubrication systems are necessary. Roll changes are made quickly, easily and economically. And since Timken bearings may be selected to take any combination of radial and thrust loads, no supplementary thrust units are required.

You can be assured of all these advantages in new or existing equipment by specifying Timken balanced proportion bearings for back-up and work rolls. For full information about Timken tapered roll neck bearings, consult our roll neck bearing specialists. Write The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



UNITED ENGINEERING AND FOUNDRY COMPANY *assures long life, maintenance-free performance in the 96" plate mill by using Timken roll neck bearings on work rolls and back-up rolls. Typical mounting is shown above.*

NEW ENGINEERING JOURNAL!

529 PAGES! Includes new, technical information on bearing applications available nowhere else. Especially helpful to design engineers. Gives bearing dimensions, capacities, selection and mounting data. For a copy, write on your company letterhead to The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN

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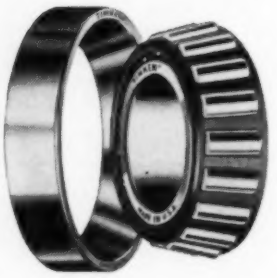
TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ◎ AND THRUST →◎← LOADS OR ANY COMBINATION ✳

a compact, complete small mill. No cellars or elaborate foundations needed

TO meet the need of many manufacturers for a small, compact, inexpensive mill for the cold rolling of narrow, thin strip, UNITED developed, and is now offering, a NEW, COMPLETELY INTEGRATED "PACKAGE MILL."

Each unit is furnished fully equipped with roller bearing mounted rolls, recirculating rolling coolant system, mill guides, tension reels, belt wrappers if desired, strippers, motors and drives, all mounted on a fabricated base which serves also as a rolling coolant reservoir. The mill illustrated is a reversing type with motorized screwdown.

If a small, compact, completely self-contained "Package Mill" of this type fits into your present operations or contemplated expansion, consult us. Your inquiry will bring complete information at no obligation.

- **Mill can be equipped for one way rolling by using a simple coil box instead of a reel.**
- **Sleeve type or collapsing mandrels are optional with or without grippers to meet user's requirements.**
- **Hand screwdown can be furnished instead of motorized screwdown as shown.**

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Pittsburgh, Pennsylvania

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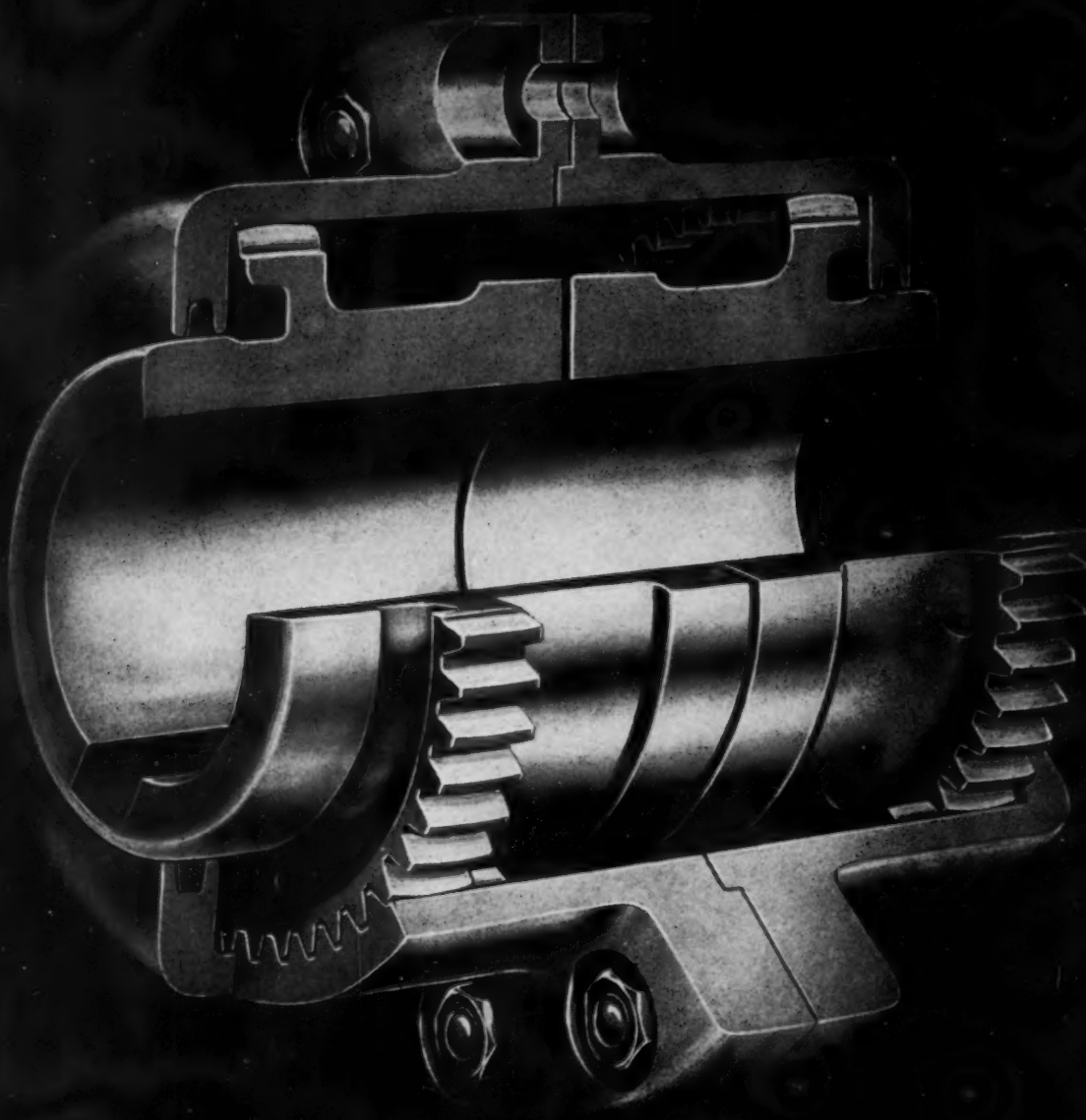
Designers and Builders of Ferrous and Non-Ferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other heavy machinery. Manufacturers of Iron, Nodular Iron and Steel Castings and Weldments.

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

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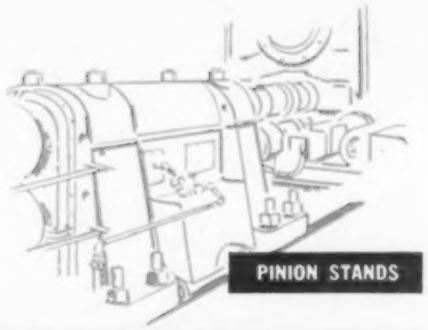
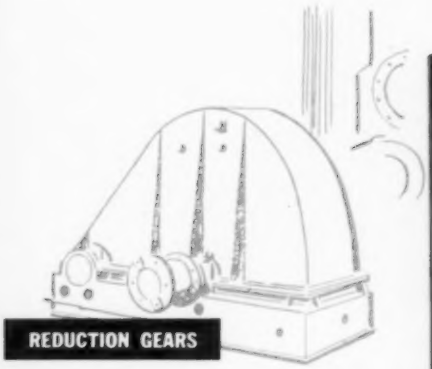
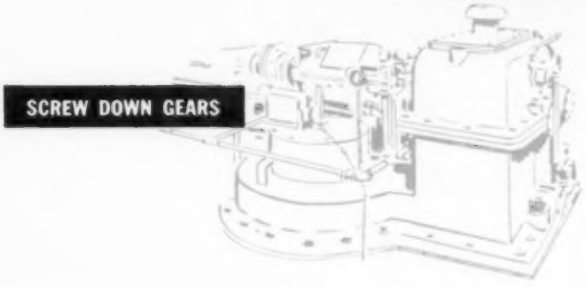




Gulf E.P. Lubricants



Gulf E. P. Lubricants are specially compounded to withstand the shock loads and high pressures encountered in the most severe service. Their extra load-carrying capacity is more than ample to protect any well designed gear—prevent excessive wear, keep maintenance costs low.

In addition to higher lubricating value, Gulf E. P. Lubricants have many other features that insure lower maintenance costs and freedom from lubrication troubles. They are exceptionally stable, in storage or in use; have unusually good water separating characteristics; contain a special corrosion inhibitor which protects against rust; and are nonfoaming and noncorrosive.

Gulf E. P. Lubricants are ideal for many steel mill applications, and are particularly recommended for pinion stands, reduction gears, and gear-driven table rollers.

For more complete information on these outstanding gear lubricants or for expert help on the lubrication and maintenance of your gear drives, send the coupon below.

Play safe with Gulf E. P. Lubricants

- **High film strength—prevent metal to metal contact and excessive wear.**
- **Extremely stable—do not separate in use or in storage.**
- **Prevent rust — contain a special corrosion inhibitor.**
- **Have excellent water separating characteristics.**
- **Nonfoaming · noncorrosive.**

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Gentlemen:

☐ Please send me, without obligation, a copy of your pamphlet "Gulf E. P. Lubricants."

☐ Please have an experienced Gulf Lubrication Engineer call on us to discuss improved gear lubrication.

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Pressure-Seal Bonnet Gate—available in 600, 900, and 1500 pound classes

You spend less for it

by using Dependable Quality

CRANE VALVES

...That's why more Crane Valves are used than any other make

NO BONNET JOINT LEAKAGE . . .
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Big maintenance savings can be made on high-pressure/high-temperature piping services by using Crane Pressure-Seal Bonnet valves in place of bolted bonnet valves. Once installed, these valves rarely need maintenance of the bonnet joint—line pressure keeps it leak-tight.

Lighter weight and more compact dimensions make savings in piping erection and suspension. Streamlined body design reduces insulating costs.

Other outstanding and typical features of Crane Pressure-Seal Bonnet Joint design are tailored-to-the-service alloy steels, Stellite trim, deep stuffing box, and flexible wedge disc in larger gates. In gates, globes, angles, or stop-checks, these valves are an investment in better piping performance at lower ultimate cost.

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KEYSTONE INSULATORS STAND HEAT...WEATHER...SHOCK

Current for ingot buggies must be maintained under the most rugged operating conditions of heat, cold and shock. That's why Keystone Contact Rail Insulator Type DDI is so extensively used by many of the nation's largest steel mills.

The heavy glazed semi-porcelain block of this insulator provides reliable support and insulation of contact rails. Malleable iron cap cemented to block is equipped with adjustable lugs adaptable to standard rails from 30 to 65 lbs. (Type DD to 95 lbs.). Ease of installation is accomplished with a single mounting bolt.

Throughout the nation—on cranes, conveyors and other electrical hoisting and handling systems—the Keystone Line of Insulators and Collectors is providing positive power for moving contacts in leading steel mills. Details on the complete line are available in the new Keystone Catalog. Write for your copy.

KEYSTONE UNDER-CONTACT RAIL SYSTEM

Assembly No. 45813 for supporting two rails where two conductors are required—for multi-phase work or remote control operation.

KEYSTONE CONTACT RAIL INSULATOR

Type HA for over-running contacts. Permits free movement of rail . . . providing for contraction and expansion due to temperature.

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MANUFACTURERS OF COMPLETE LINE OF INSULATOR SUPPORTS FOR RAIL AND WIRE CONDUCTORS AND CURRENT COLLECTION DEVICES

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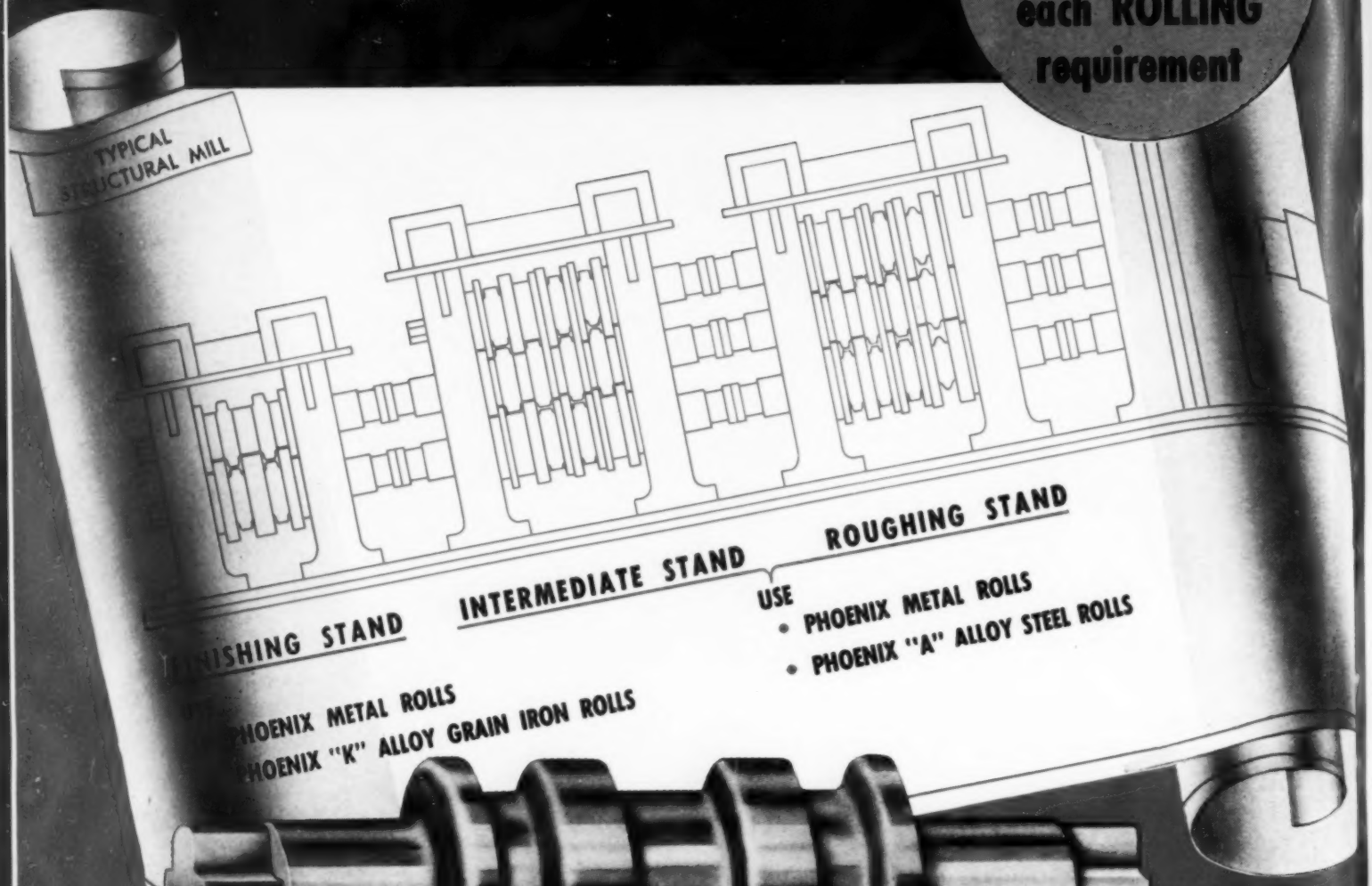

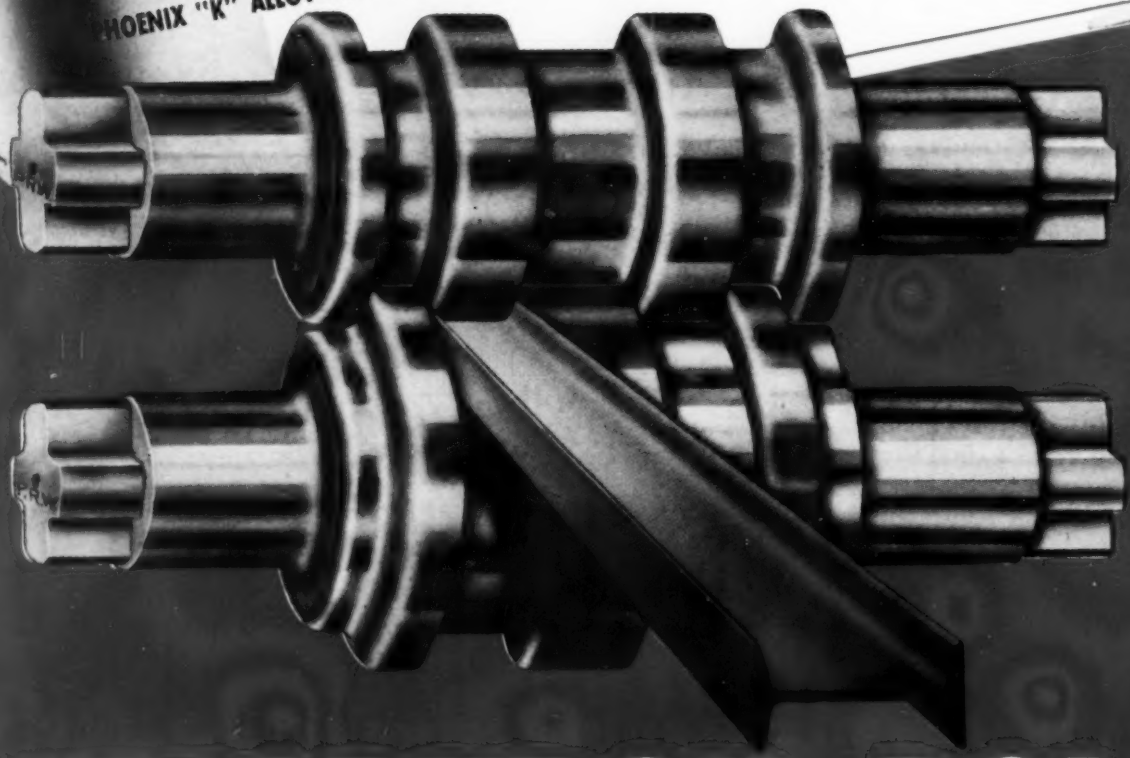

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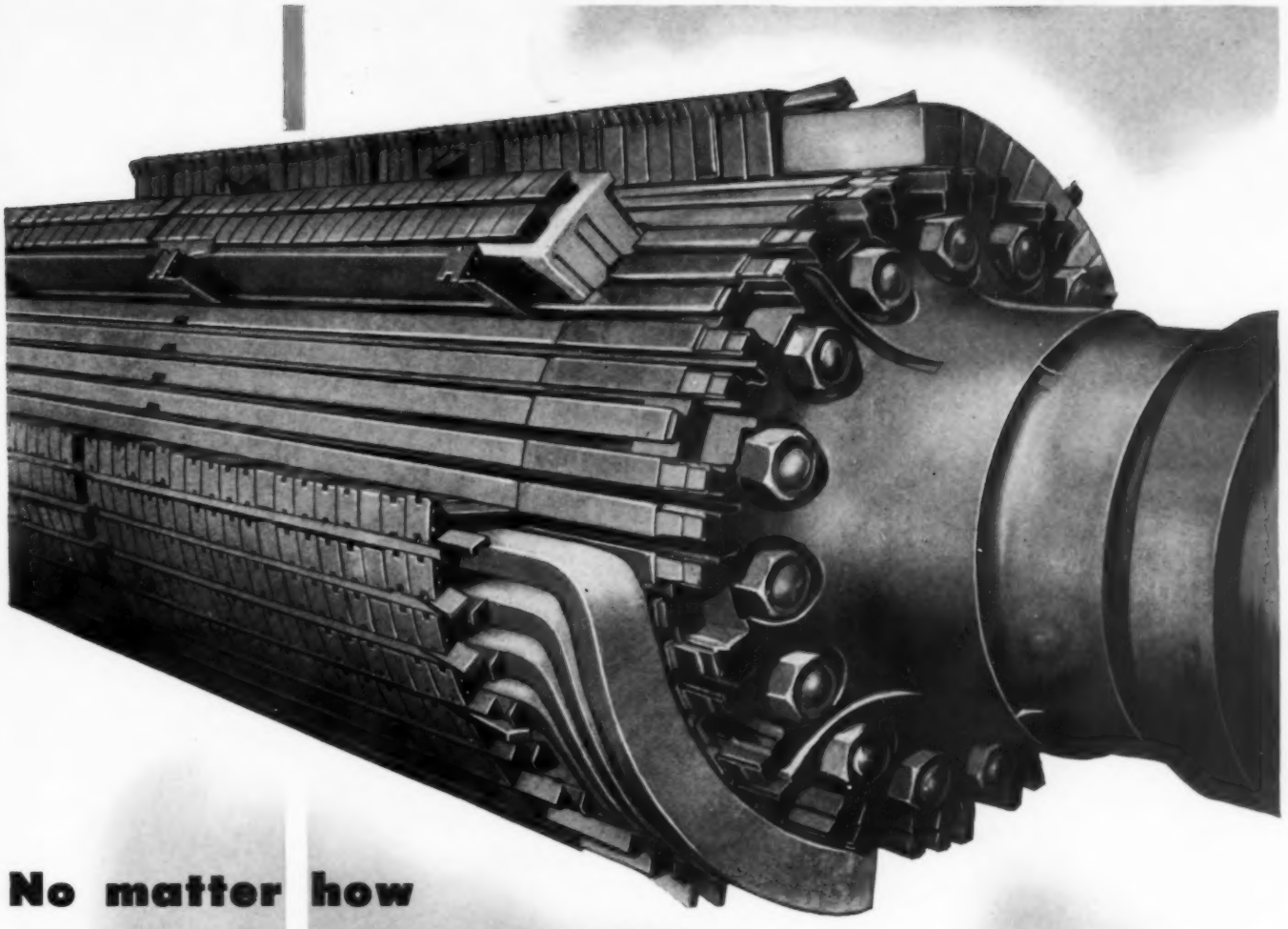
PITTSBURGH ROLLS DIVISION OF BLAW-KNOX COMPANY • PITTSBURGH, PA.



No matter how unusual your generator may be . . .

we can build New-Born Power into it!

Peculiarities of design such as those in the turbo-alternator rotor above, photographed in our shop, hold no terrors for National Electric Coil engineers. In this case, removable tooth-sections allow the field coils to be hot-pressed and seasoned as a complete coil unit. Each finished coil is placed on the rotor core and the tooth-sections are inserted. National is prepared, by experience and equipment, to take advantage of every opportunity afforded by design and construction to give you maximum power and life. *Now* is the time to make sure your rotating electrical equipment is ready for the job which lies ahead. Write or wire (or cable Natcoil, Columbus).

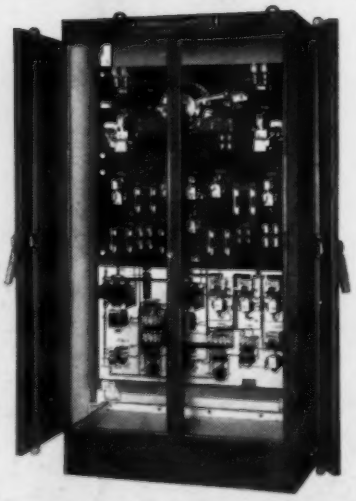
NATIONAL ELECTRIC COIL COMPANY

COLUMBUS 16, OHIO, U. S. A.

ELECTRICAL ENGINEERS: MAKERS OF ELECTRICAL COILS AND INSULATION—REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

SQUARE D FIELD ENGINEERING *in action!*

PROBLEM To design a panel that would automatically control, sequence and indicate the progress of the entire charging operation for this #2 blast furnace located at the Clairton Works of United States Steel Company.



SOLUTION

Square D designed and built this simple and easily maintained master panel to control and sequence existing motor starters—utilizing standard components from Square D's complete line of heavy duty equipment. One man now controls the entire charging operation from a master station . . . a typical example of Square D field engineering in action — conserving materials, time and effort while increasing the factor of safety.

SQUARE D FIELD ENGINEERS ARE AT YOUR SERVICE
THROUGH BRANCH OFFICES IN ALL PRINCIPAL CITIES

SQUARE D COMPANY

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Bliss Modernizes Temper Mill at U. S. Steel's Irvin Works

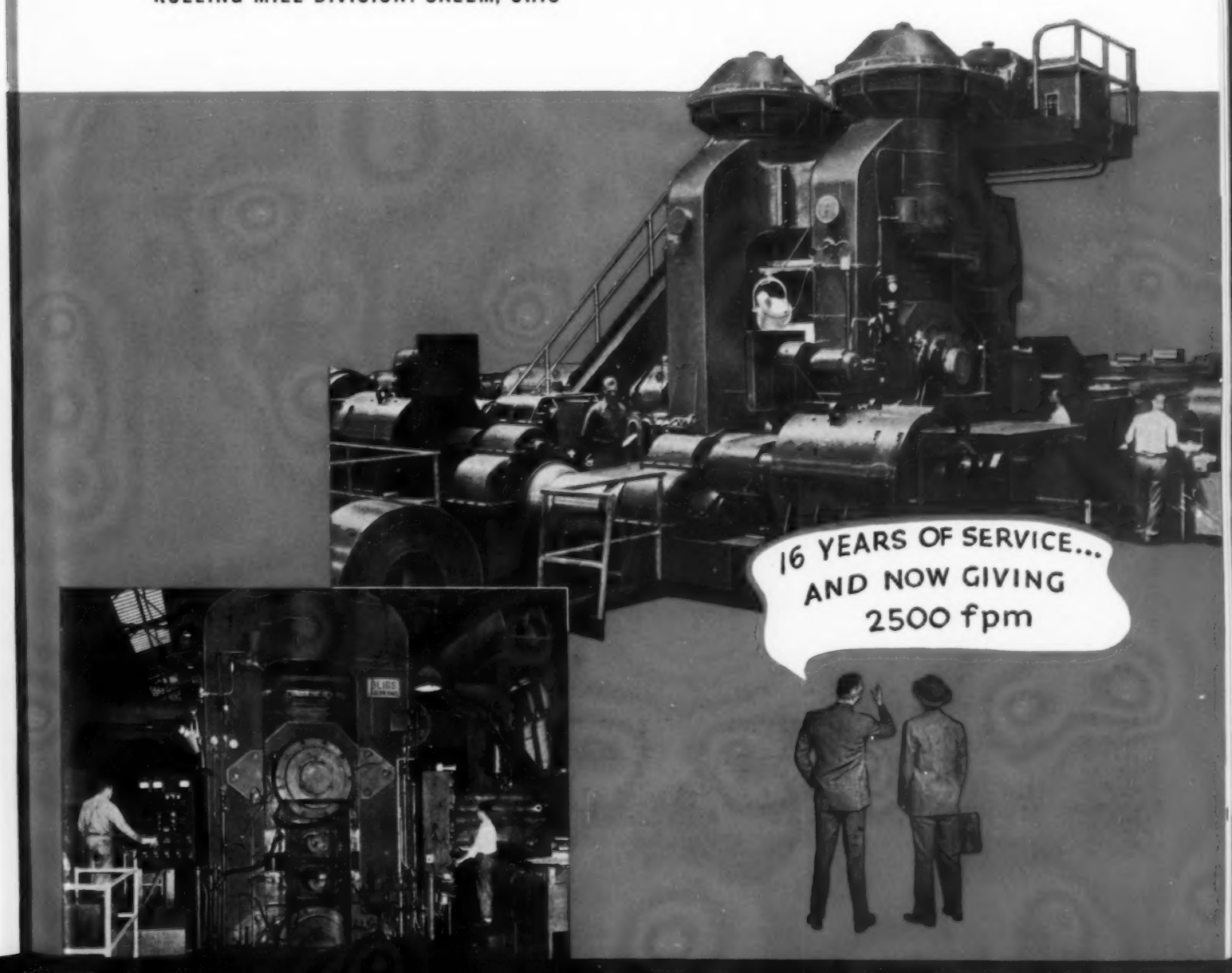
After 16 years of rugged service—much of it 'round the clock—a Bliss 4-high temper pass mill, at United States Steel Company's Irvin Works, was recently rebuilt by Bliss engineers. Its speed was increased to 2500 fpm.

U. S. Steel sees a future range of 250 to 3750 fpm for this *completely modern mill*, now handling coils of steel up to 50 inches wide, 72 inches in diameter, and weighing 50,000 pounds. All operations are directed from cabinets at each end—tension being controlled to any desired degree through the full cycle of any pass.

Bliss engineers are called upon for modernization jobs like this because of customers' satisfaction with Bliss mill performance. With more than 90 years' experience serving the metal industries, Bliss engineers can help you, too, solve urgent expansion problems—supplying new equipment, or modernizing the old.

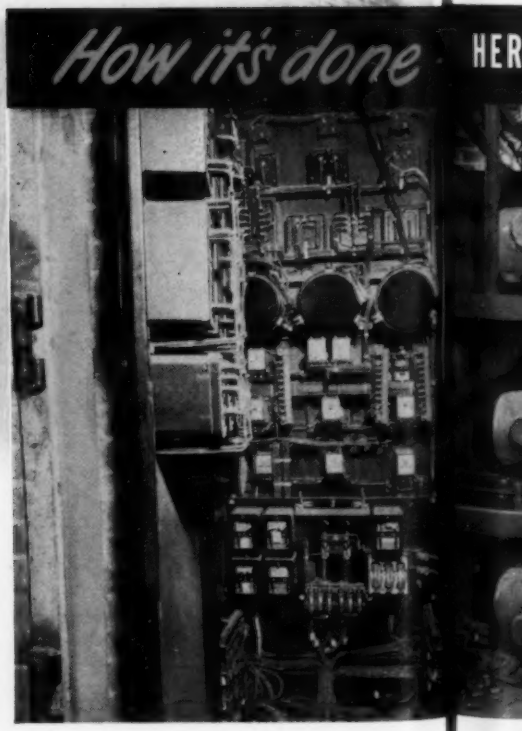
If you plan improvements in either hot-rolling or cold-rolling facilities—ferrous or non-ferrous—put your problem up to Bliss engineers. They will see your job through to completion.

E. W. BLISS COMPANY, General Office: Canton, Ohio
ROLLING MILL DIVISION: SALEM, OHIO



Westinghouse

EQUIPMENT FOR THE STEEL INDUSTRY



Furnace Control with Optimelt-Control feature maintains the arc in its most economical phase. No power is wasted; the proper amount is supplied *when* it's needed. Write for IB 31-280 CS-1 and CS-2.

YOU CAN BE **SURE**.. IF IT'S

Westinghouse

OUTPUT BOOSTED 5%— AND LESS POWER USED!

Here's news whether or not you're interested in electric furnaces right now. Because the same feel-for-steel engineering that made these remarkable improvements is available to help make your next job better, whatever it is.

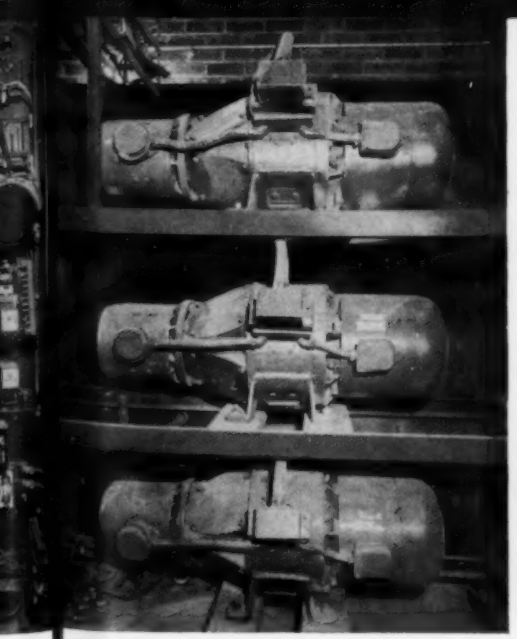
To determine the precise superiority of Westinghouse Optimelt-controlled electric furnaces, one major steel producer pitted them against identical furnaces with manual control. The mill dug up its own proof in a seven-month-long check of actual operations.

Under identical charge conditions, the Westinghouse-controlled furnaces made *5% more steel per furnace hour.* Yet they actually used 2½% less power per ton of steel poured. And they cut electrode consumption and reduced furnace delays.

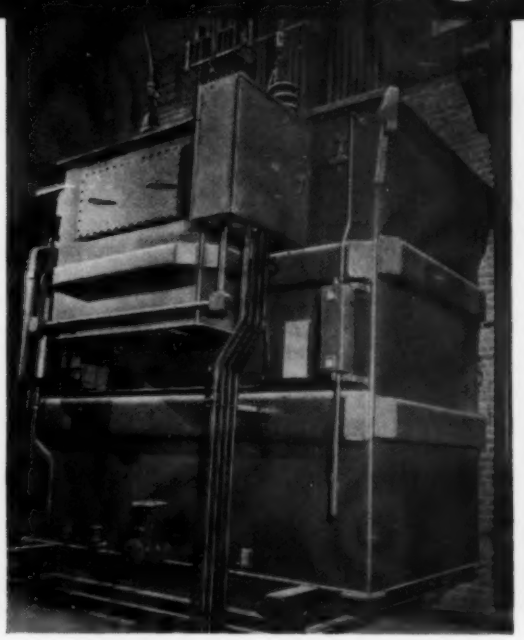
This is the kind of dollar-saving engineering that Westinghouse applies to steel mill electrical equipment. When you're planning your next installation, call in Westinghouse early. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

J-94846

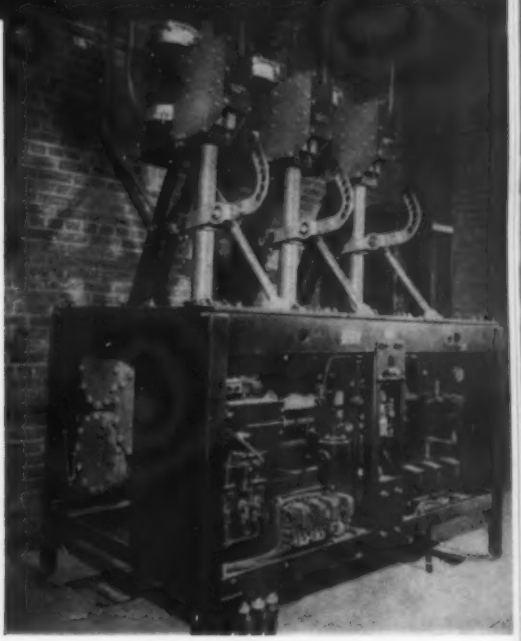
HERE'S THE EQUIPMENT BEHIND THE SUPERIORITY OF Ⓦ-CONTROLLED ELECTRIC FURNACES



Rototrol Regulator positions electrodes quickly, accurately, and *automatically* as furnace conditions change. Shown above: M-G sets for positioning three electrodes with Rototrol unit mounted at left end of each.

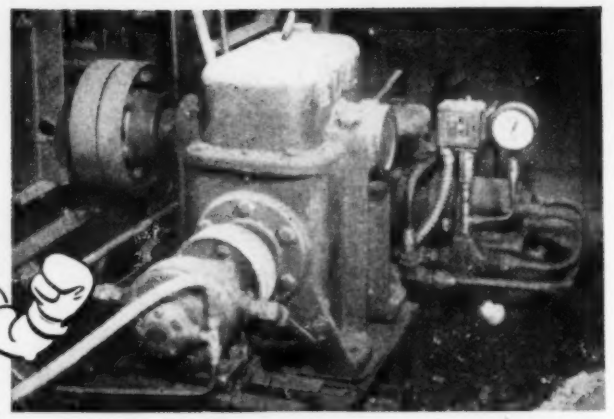


Furnace-type Transformer continually transforms main mill power for exacting furnace requirements. Transformer is built in shell construction for maximum bracing strength and optimum cooling conditions.



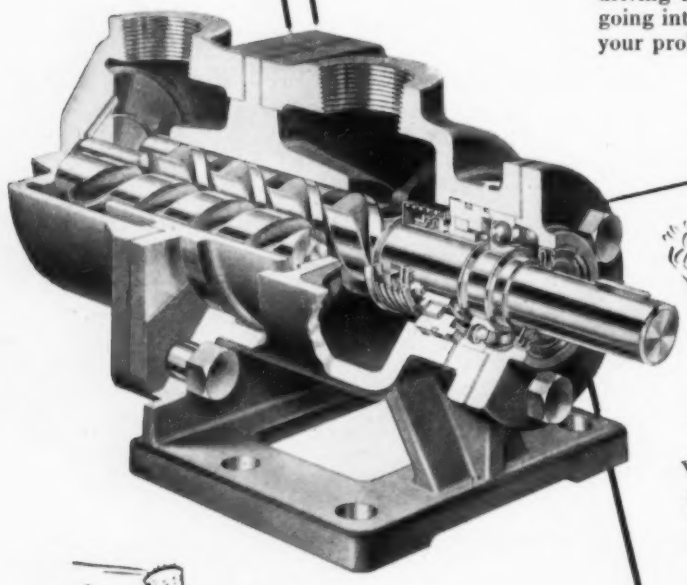
Compressed Air Circuit Breakers are specially designed for the severe repetitive duty of arc furnace operation. They withstand 15,000 operations between inspections. Surge suppressors reduce overvoltages.

De Laval products at work!



Tough service?... You bet!

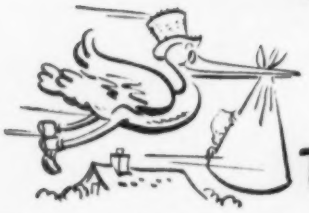
0 to 800 rpm in 8/10 Second . . . 26 Times per Minute. And this De Laval speed reducer takes it and likes it. This particular unit is driving a conveyor belt that automatically feeds and measures billets going into a shear. If you are rough on reducers in your plant, tell your problems to one of our power transmission engineers.



What do you want to pump?

Molasses, Glue, Lard, Soya Oil, Film Dope, Corn Syrup, Vegetable Oil, Paste, Fuel Oil, Shortening, Resin, Varnish, Linseed Oil, Viscose Rayon, Liquid Latex . . .

We frankly don't know all the other products that an IMO can pump, but if you want a better way to transfer fluids like these from one place to another, chances are an IMO can do the job for you. The IMO is a screw-type rotary pump. Its axial flow design permits liquids to be pumped close to the axis of the rotor. This means low liquid velocity through the pump and quiet pulsation-free flow. Capacities range to 1000 gpm at 500 psi and 150 gpm at 1500 psi.



There's a new idea here!

We've simplified the already simple centrifugal pump! Our new GS pump is designed so that every working part . . . every part subject to wear, is contained in one easily replaced unit rotor assembly. Through our Service and Exchange Plan new rotor assemblies are available for immediate shipment from conveniently located stocks throughout the country.

This means good service, and if maintenance ever does become necessary, all you have to do is remove the cover and end plate bolts, lift out the old rotor and drop a new one in place. *It's that easy!* Capacities to 400 gpm — heads to 230 feet.

DE LAVAL STEAM TURBINE CO., TRENTON 2, N. J.

TURBINES • HELICAL GEARS • CENTRIFUGAL BLOWERS AND COMPRESSORS
CENTRIFUGAL PUMPS • WORM GEAR SPEED REDUCERS • IMO OIL PUMPS

50th DE LAVAL Anniversary

Investing in a Heyl & Patterson

KINNEY CAR UNLOADER

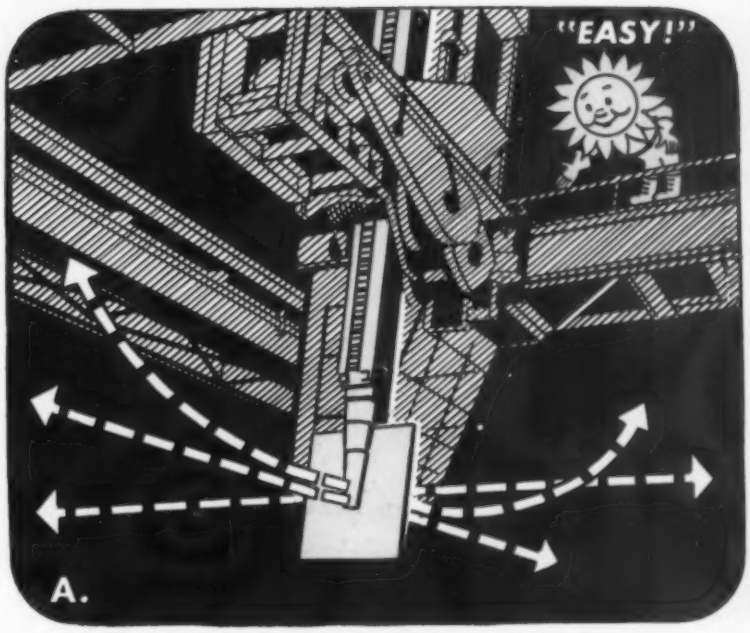
is Equivalent to Buying Insurance that

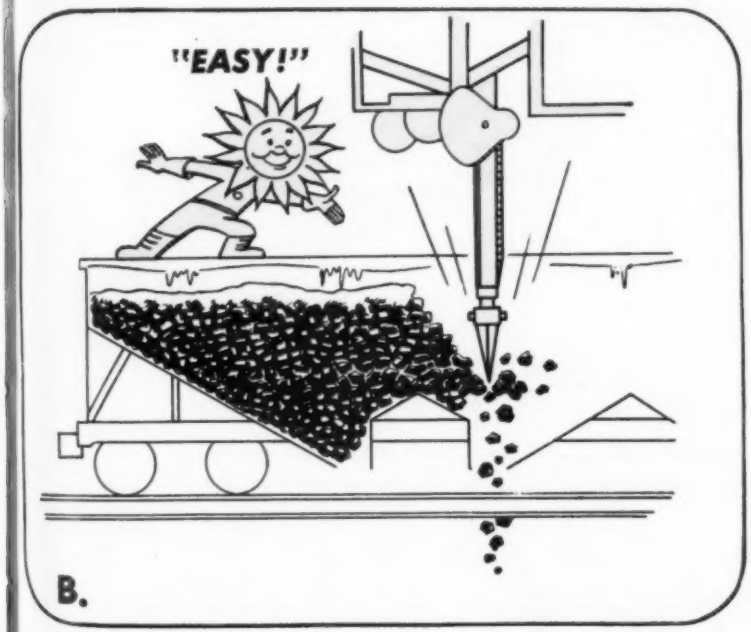
PROTECTS YOUR PRODUCTION IN SEVERE WINTER WEATHER

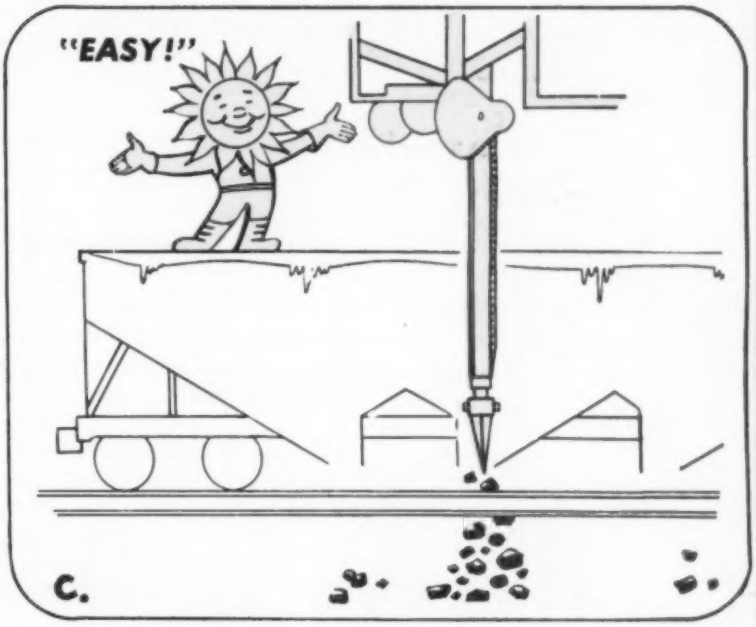
"EASY" Does It. (A) The H&P Kinney Car Unloader consists of a movable bridge equipped with a trolley which carries the Unloading Spade and its operating mechanism. The bridge may run on a Crane Runway or may be designed as a Gantry.

"EASY" Does It. (B) In breaking up frozen coal and forcing it through the hopper opening the frozen chunks are reduced in size to where they will not clog the track hopper or feeders and can be handled on a conveyor belt.

"EASY" Does It. (C) The H&P Kinney Car Unloader enables one man to unload a 70-Ton Car of Frozen Coal in 20 minutes or less. It can also be used as a Car Mover.







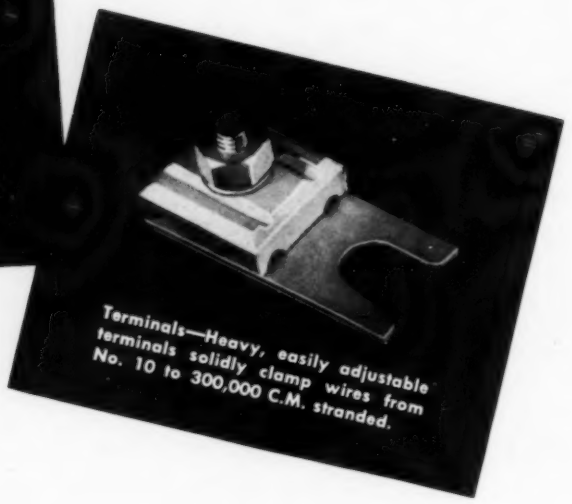
Ore Bridges
Railroad Car Dumpers
High Lift-Turnover-Rotary
Coal Preparation Plants
Coal & Coke Handling Equipment
Boat Loaders and Unloaders
Rotary Mine Car Dumpers
Coal Crushers
Coal Storage Bridges
Car Hauls & Boat Movers
Bradford Breakers
Refuse Disposal Cars
Thorsten Coal Samplers
Kinney Car Unloaders
Pig Iron Casting Machines
Cyclone Thickeners
Thermal Dryers

Heavy Bulk Materials Handling Equipment
All the Way from Design to Erection

Heyl & Patterson, Inc.
"SINCE 1887"
55 WATER STREET · PITTSBURGH 22, PA.

Ask a Heyl & Patterson Engineer to Consult with You or Write for Bulletin 2-50-KCU

P-G Steel Grid—Designed to eliminate hot spots and insure even heat distribution.



Terminals—Heavy, easily adjustable terminals solidly clamp wires from No. 10 to 300,000 C.M. stranded.

Floating Bolts—The supporting bolts are free to float in the oblong holes.

3 Plus Factors

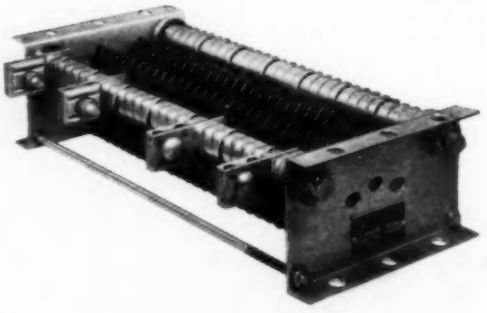
IN P-G Steel Grid Resistors

for BETTER PERFORMANCE with LESS MAINTENANCE!

1. **GRIDS** are punched from corrosion-resisting, special chromium alloy steel sheets and retain their mechanical strength even at a red heat.

2. **FLOATING BOLT** construction, as used in P-G Resistors, allows the grids to expand under heat. This feature prevents warp or buckle since the grids are free to move within their maximum limits of expansion.

3. **TERMINALS** are heavy steel and malleable iron. The open eye in the terminal plate makes it easily possible to move connection to any position in the bank.



These 3 plus factors . . . combined with many other P-G practical features of design, plus steel and mica as basic materials, assure long resistor life.

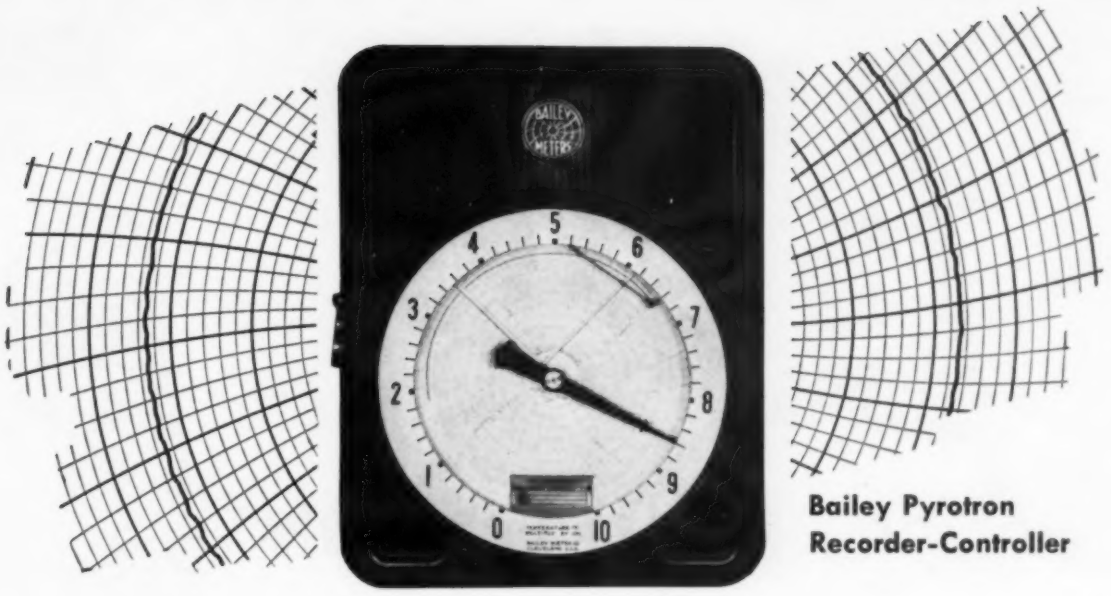
P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO



Bailey Pyrotron
Recorder-Controller

Looking for Better Temperature Instruments?

. . . Then check these features of Pyrotron Electronic Resistance Thermometers . . .

FUNDAMENTAL ACCURACY

Bailey Pyrotron Resistance Elements are made of highest purity platinum—the material used by the National Bureau of Standards in establishing basic standards for temperatures from −190°C to +660°C.

THREE TYPES OF CONTROL

Pyrotron Controllers may operate: on-off electrical systems by either electronic relays or electric contacts, modulated electronic systems, or air-operated systems. Two temperatures may be recorded on the same chart and controlled by a single instrument.

FACTS PUT INTO USABLE FORM

Bailey Pyrotrons may be arranged to put temperature facts into convenient usable forms. If two or more temperatures are related, they may be recorded as continuous records on the same chart for easy comparison. The average of several temperatures or the difference between two temperatures may be recorded as a single continuous record which may be retransmitted to a distant point or used to actuate a control system.

EASY INSTALLATION

Bailey Pyrotrons do not require careful leveling or protection against vibration. Three ordinary copper wires are all that is needed to connect each temperature sensitive element with the recorder. Power may be taken from any 115 volt 60 cycle circuit.

MINIMUM MAINTENANCE

The absence of galvanometers, batteries and standardizing equipment, together with the use of interchangeable unit assemblies, reduces Pyrotron maintenance to the vanishing point.

ABUNDANT POWER

A separate motor drive for each temperature furnishes abundant power to operate a recording pen, a controller and an alarm switch.

For the full story on this unusual electronic resistance thermometer which is suitable for ranges between −300°F and 1200°F, ask for Bulletin No. 230-C. P-21

BAILEY METER COMPANY

1047 IVANHOE ROAD • • • CLEVELAND 10, OHIO

Controls for Processing

TEMPERATURE
PRESSURE
% OXYGEN
% COMBUSTION
FLOW
LEVEL
DENSITY
RATIO

Light! ... for PROTECTION

Type DCX-18 Searchlight

Type ADE-14 Floodlight

Type LCE-1120 Floodlight

America is faced with the ever-present danger of sabotage that would cripple vital services and production facilities. Sabotage thrives in darkness. The most reliable and cheapest form of protection against night prowlers is LIGHT!

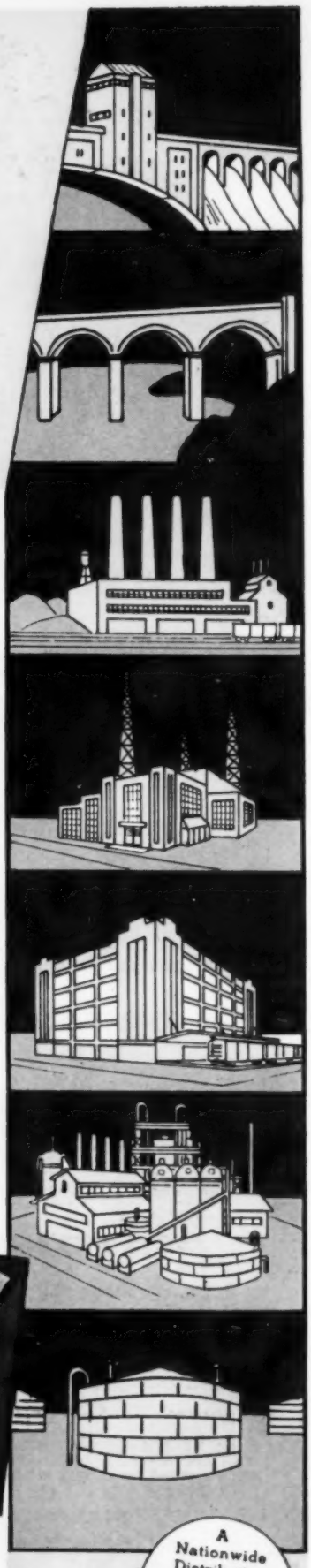
CROUSE-HINDS Floodlights

project powerful beams of light that bathe all approaches to your property with glaring radiance, killing darkness and shadows and compelling everyone to be more visible at night than in broad daylight.

The protective power of light should be used in all important municipal and industrial locations, including waterworks, dams, pumping stations, gas works and gas storage tanks, electric power plants and substations, factories, mills, mines, bridges, docks, warehouses, railway terminals, tunnels, shops and freight houses, canal locks, and aqueducts, oil refineries, pump houses and storage tanks, telephone and telegraph stations, radio stations.

The floodlighting of industrial plants serves a double purpose. It helps to boost production in addition to the security it provides.

Crouse-Hinds offers a complete line of floodlights and searchlights that will meet the needs of any type of protective lighting. Crouse-Hinds illumination engineers have a wealth of protective lighting knowledge that is at your service. Send for your copy of Bulletin 2565, "LIGHT! Protect Your Property."



A Nationwide Distribution Through Electrical Wholesalers

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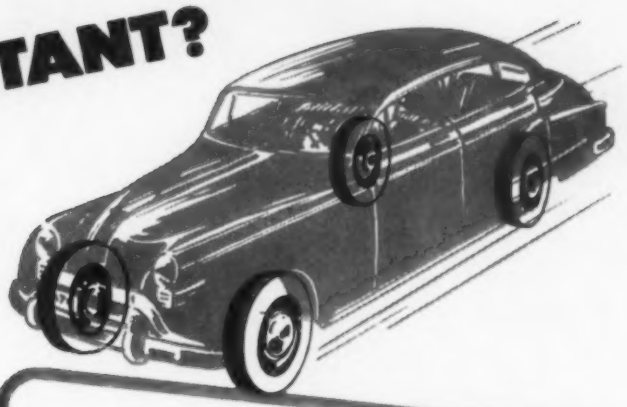
Syracuse 1, N. Y.

Offices: Birmingham — Boston — Buffalo — Chicago — Cincinnati — Cleveland — Dallas Denver — Detroit — Houston — Indianapolis — Kansas City — Los Angeles — Milwaukee Minneapolis — New York — Philadelphia — Pittsburgh — Portland, Ore. — Salt Lake City San Francisco — Seattle — St. Louis — Washington. *Resident Representatives:* Albany Atlanta — Baltimore — Charlotte — New Orleans — Richmond, Va.
CROUSE-HINDS COMPANY OF CANADA, LTD., TORONTO, ONT.

FLOODLIGHTS · AIRPORT LIGHTING · TRAFFIC SIGNALS · CONDULETS

WHICH WHEEL IS THE MOST IMPORTANT?

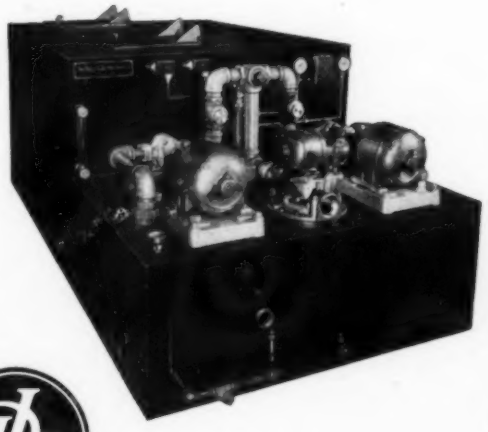


None, obviously—*all* are of equal importance. Likewise when it comes to designing steel mill lubrication, De Laval engineers know the importance of balancing all four fundamentals that are necessary in *every* system.

Size is immaterial. Some mills are large enough to require a completely engineered, "custom-built" system. Some are small enough to require only a De Laval Unilube. The Unilube is a self-contained unit with circulating capacities of 1 to 40 gpm.

Send for Bulletin No. 500.

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, N. Y. 6 427 Randolph St., Chicago 6
DE LAVAL SALES & SERVICE, INC.
447 Fourth Ave., Pittsburgh 19
DE LAVAL PACIFIC COMPANY
61 Beale St., San Francisco 5



PURIFICATION OF LUBRICATING OIL

De Laval Oil Purifiers, furnished as part of the design where possible, are permanently piped to the system to permit centrifugal by-pass purification of the lubricant in service. The Purifiers remove water and fine solid contaminants.

CORRECT METERING OF LUBRICANT

De Laval Systems stress supplying each bearing and gear mesh point with exactly the right amount of lubricant. A constant streamline flow of lubricant in the correct quantity and pressure must be maintained at all times.

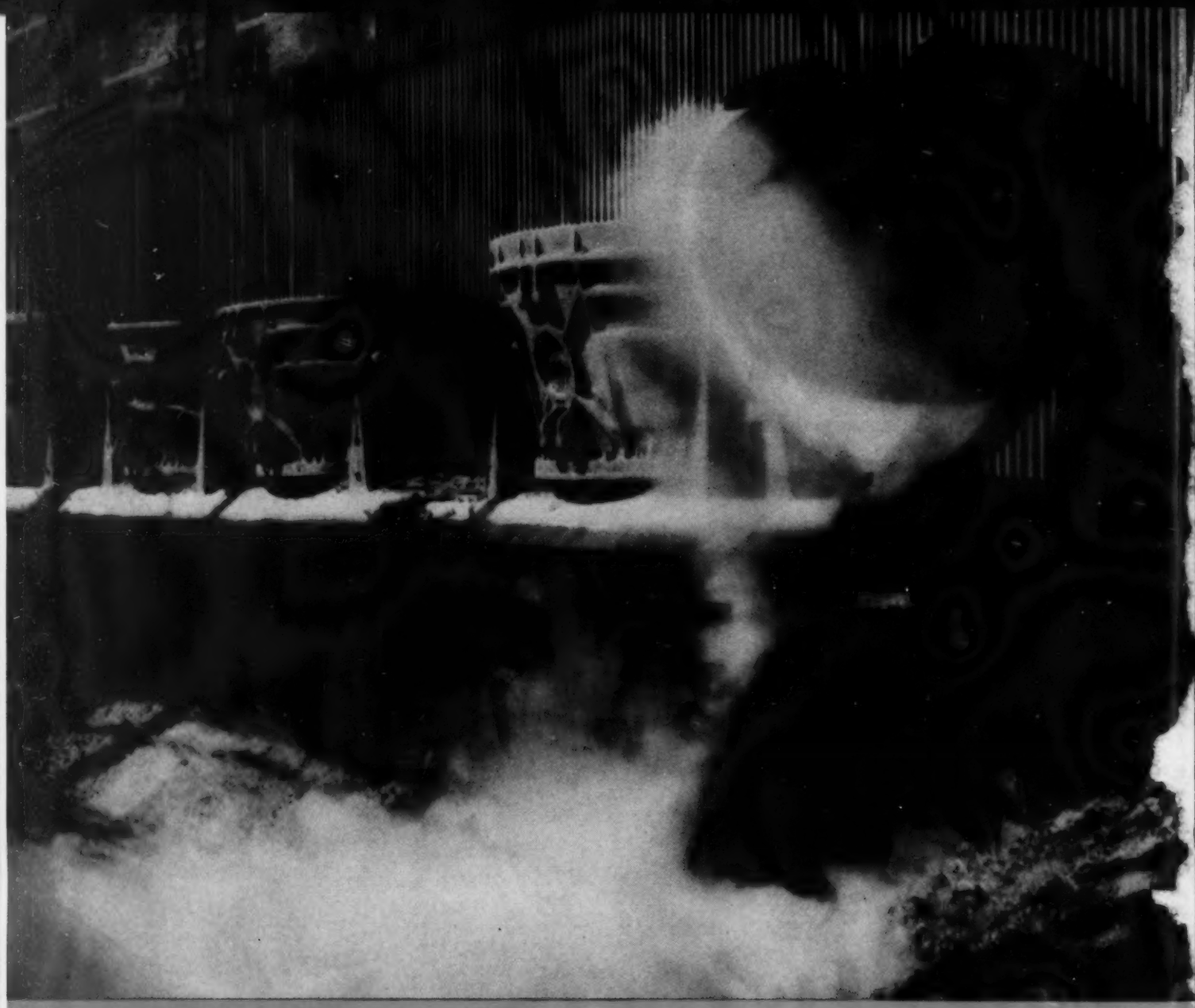
PROPER SELECTION OF PIPE SIZE

The proper selection of pipe size is important to provide efficient lubrication. All De Laval Systems are designed to keep the pressure drop due to line friction at a minimum, and to insure a streamline flow.

EFFICIENT TEMPERATURE CONTROL

De Laval Systems incorporate a constant control of the lubricant temperature both winter and summer. By the use of efficient heating or cooling facilities, a continuous flow of lubricant at the correct temperature and viscosity is maintained.

DE LAVAL ENGINEERED SYSTEMS



These JOHNSTON CINDER POTS Reduced Slag-handling Costs

Their records are worth investigating

Perhaps you judge cinder-pot service by the number of trips to the slag dump—That's one place Johnston Cinder Pots have established service records.

Your disposal system may require a fast turn-around cycle—a specification made to order for Johnston Cinder Pots with their patented flexible sidewall construction which speeds-up dumping.

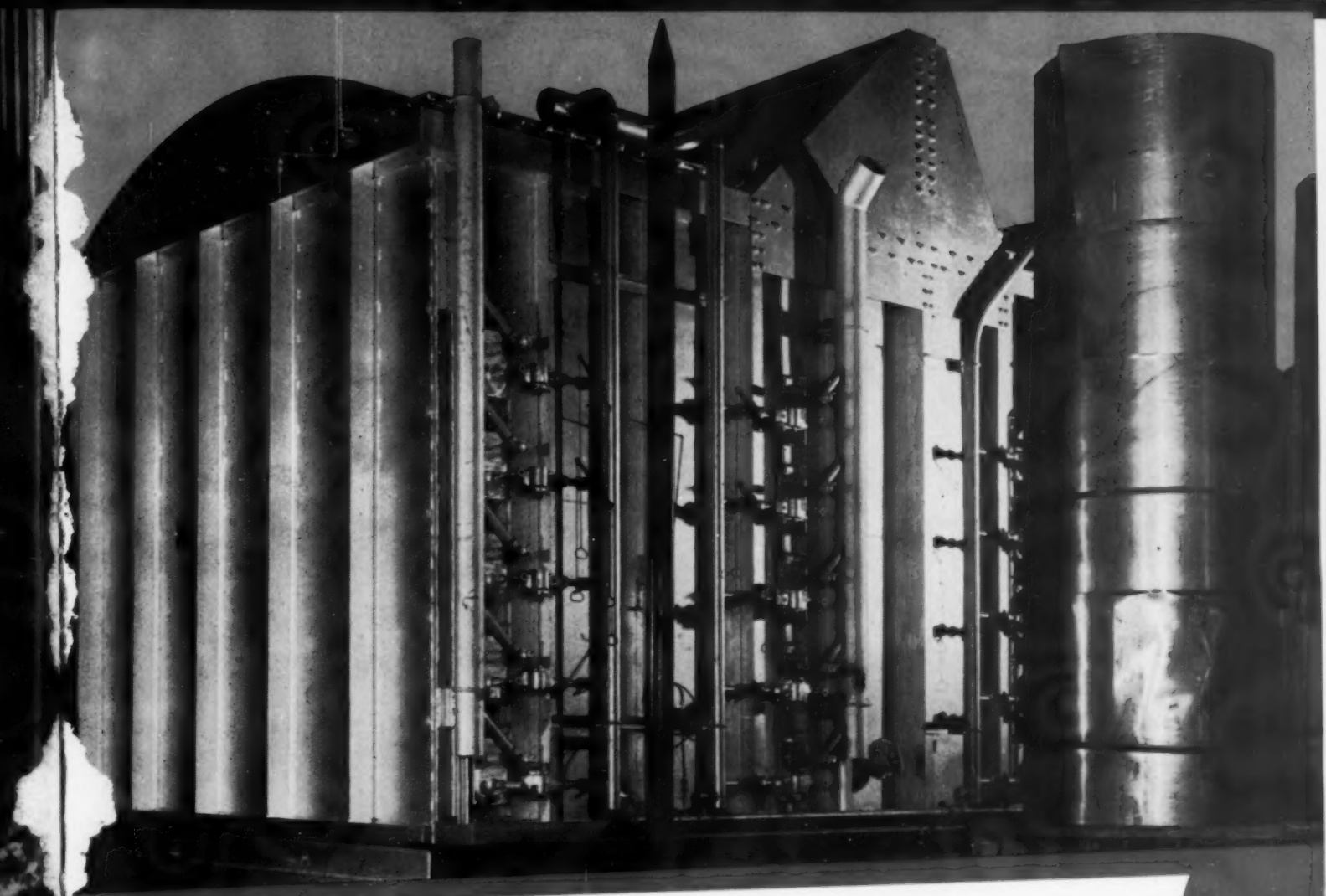
But there's one other essential fact you should know . . .

Johnston Cinder Pots have reduced slag-handling costs in every blast-furnace and open-hearth operation to which they have been applied.

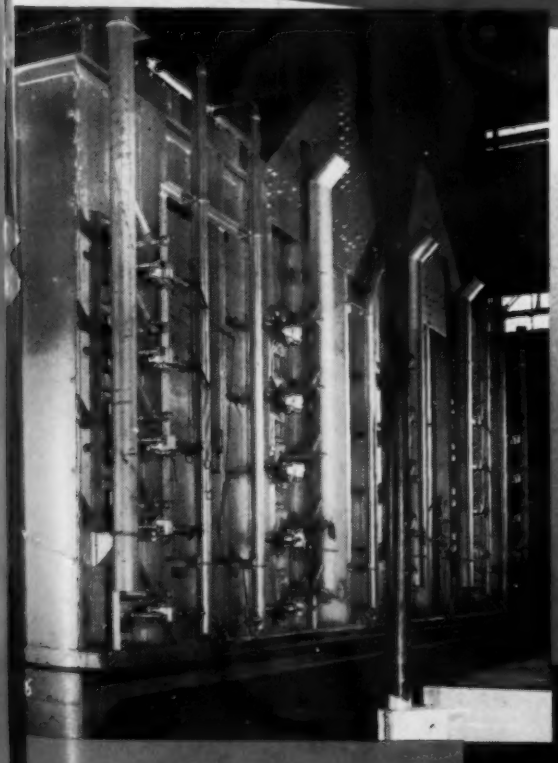
We're ready to show you *how, where* and *why.*

MACKINTOSH-HEMPHILL COMPANY
PITTSBURGH & MIDLAND, PA.

MACKINTOSH-HEMPHILL PRODUCTS INCLUDE: rolls . . . steel and special alloy castings . . . completely integrated strip mills . . . heavy duty engine lathes . . . the new Mackintosh-Hemphill rotary straighteners . . . improved Johnston patented corrugated cinder pots and slag-handling equipment . . . shape straighteners . . . end-thrust bearings . . . shears . . . levellers.



SWINDELL-DRESSLER



. . . constructs for JONES & LAUGHLIN the largest* coil sheet annealing furnace ever built.

Designed for high-speed production, the unit has every proved modern advantage—among them, high-capacity base fans plus high fuel input, contributing to outstandingly greater tonnage handled per shift. • Let Swindell-Dressler consult with you on your own annealing-furnace requirements.

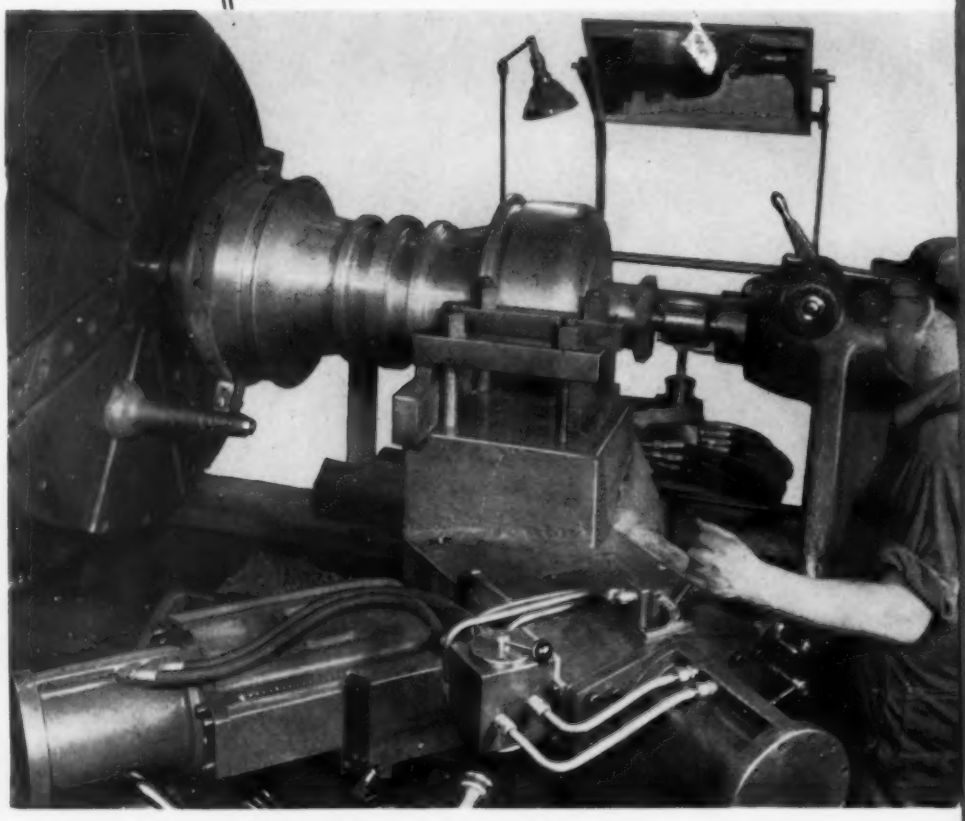
To the best of our knowledge, this 37′x19′ furnace is the largest built to date in its field.

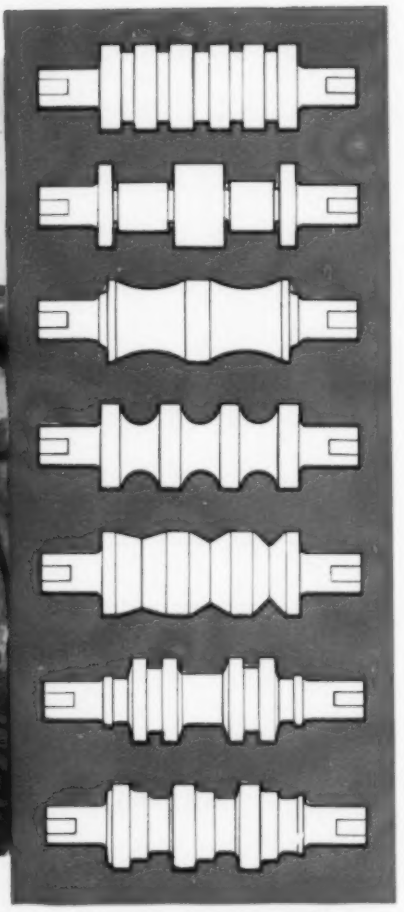
SWINDELL-DRESSLER *Corporation*

Designers and Builders of Modern Industrial Furnaces

PITTSBURGH 30, PENNA.

TURCHAN QUALITY CONTROL!





Hydraulic duplicating attachment steps up turning of mill rolls 4 to 5 times faster on standard lathes

To help you produce better work, faster, at lower cost, Turchan engineers have developed what experts acclaim the finest machining method obtainable. The Turchan Dual Follower shown above is revolutionizing production of mill rolls.

No need for specially built machines and costly form tools. Set up time is reduced to a fraction of former time. No specially trained men required.

Contours are generated from a template or model by means of a hydraulically controlled cutting tool. The cross slide is equipped with 2 compounds mounted at 45° to center line and 90° to each other, replacing the conventional slide. This creates a **new combination of movements.** Tool approach to the work is **doubled.** Any shape on left or right of center, or on the face, or a combination of both, can be machined with the simplicity of straight work.

Greater accuracies are possible due to increased rigidity of operation, as the work piece is mounted between journals, and tracer movements of cross slide are independent of mechanical movements of carriage. This is especially important in slight motion as the cutting tool responds quickly and accurately, giving a smooth, stepless finish. Size of work is limited only by the capacity of the lathe. There are also Turchan Followers for any standard milling machine, planer, shaper or grinder — tool room or mass production work. "Turn to Turchan" to increase production and cut costs!

WRITE US TODAY: Send a sketch and specifications of any roll job. Give make of machine. We'll show you how to produce it better, faster, at lower cost.

Turchan **FOLLOWER MACHINE COMPANY** 8259 LIVERNOIS AVENUE DETROIT 4, MICH.

Oldest Manufacturer of Hydraulic Duplicating Attachments for Machine Tools

EXCLUSIVE

FLUID DRIVE
reduces
clutch wear

HYPOID GEARING
30% greater strength

CHRYSLER ENGINE
65HP industrial engine
with floating power

AUTOMOTIVE TYPE SAFETY BRAKES
smooth brake action

SHOCKLESS STEERING
passenger car
steering ease

ROLLER CARRIER UPRIGHTS
low friction—long life

Only YALE combines all these modern engineering achievements in one superior gas truck!

NOW READY FOR YOU... developed to peak efficiency after 2 years of intensive on-the-job testing

JUST LOOK at the engineering and technical improvements built into this new YALE Fork Lift Gas Truck!

Here are exclusive features that will bring more time-saving, man-saving, money-saving advantages to your materials handling than was ever before possible!

In every vital part of this truck you get the finest new developments in automotive engineering—every part built for years of hard service—every part tested and re-tested under rugged on-the-job conditions.

That's why today you get smooth, powerful gas truck operation day-in day-out. On steep ramps, rough roadways, in any weather—this YALE Gas Truck *delivers*, moves, lifts and stacks the goods. Let us show you exactly *how* YALE can accomplish all of this in your plant. Write for the facts today.

Capacities up to 10,000 pounds

WRITE TODAY FOR FULL INFORMATION

The Yale & Towne Manufacturing Co., Dept. 344
Roosevelt Boulevard & Haldeman Avenue, Phila. 15, Pa.

I am interested in cutting my materials handling costs.
_____Please have your local representative call on me.
_____Please send me FREE detailed literature.

Name_____

Company_____

Street_____

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THE YALE & TOWNE MANUFACTURING COMPANY

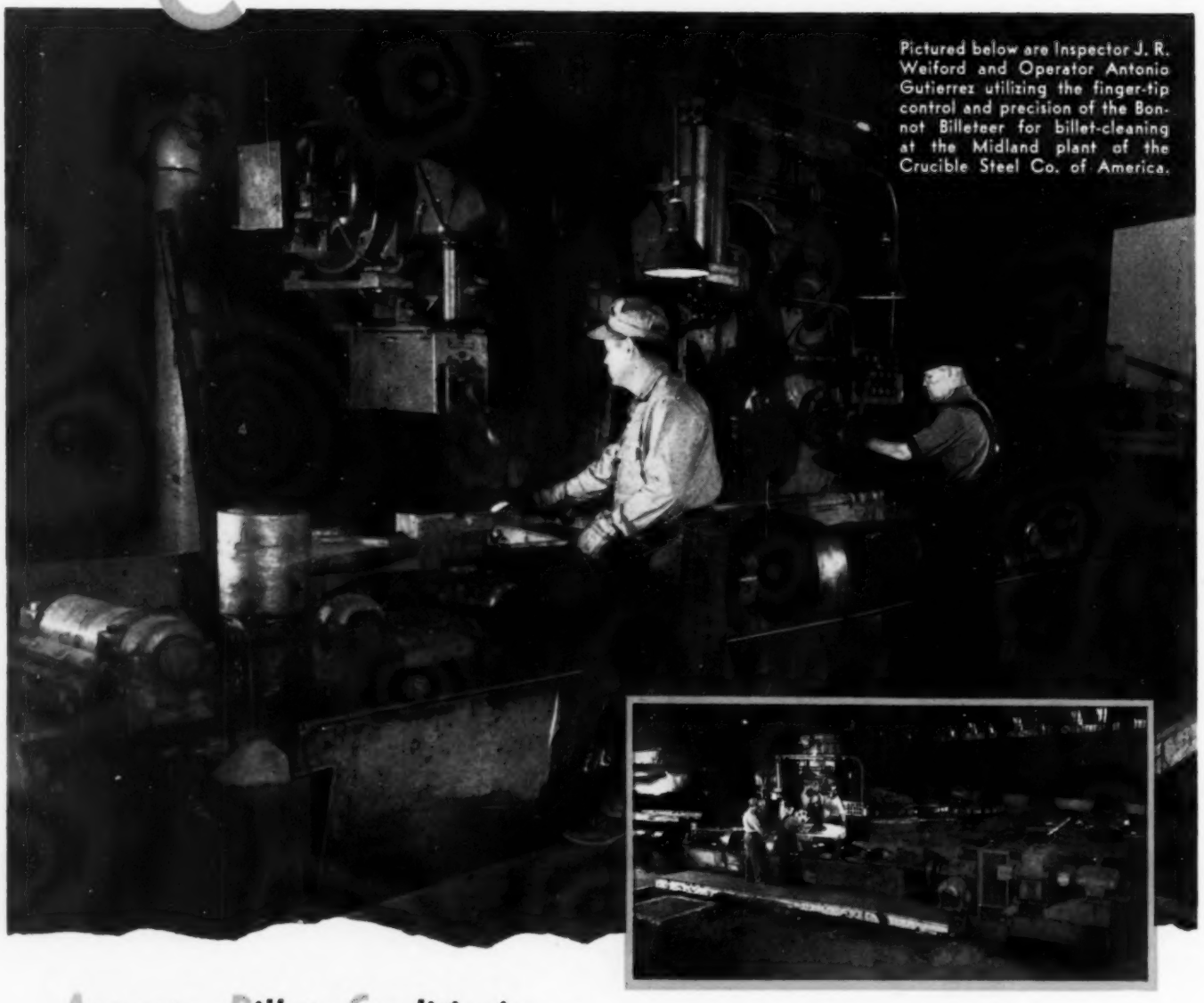
In Canada write The Yale & Towne Manufacturing Company, St. Catharines, Ontario.

YALE is the registered trademark of The Yale & Towne Manufacturing Co.

YALE

MATERIALS HANDLING EQUIPMENT
Philadelphia 15, Pa.

ACTION WITH BILLETEER AT CRUCIBLE STEEL OF AMERICA



Pictured below are Inspector J. R. Weiford and Operator Antonio Gutierrez utilizing the finger-tip control and precision of the Bonnot Billeteer for billet-cleaning at the Midland plant of the Crucible Steel Co. of America.

Accurate Billet Conditioning is a prime requisite of steel production *for war or peace,* just as the A-B-C's are fundamental to general business. With a *Bonnot Billeteer* you are assured of ACCURATE, FAST, SAFE, MODERN billet-cleaning that also REDUCES COSTS, CUTS MANPOWER TURNOVER and PROVIDES BETTER BILLETS. As at Crucible Steel, Billeteer installations are Bonnot-engineered to meet individual plant needs. For performance facts, write today!

Engineered For Improved Production

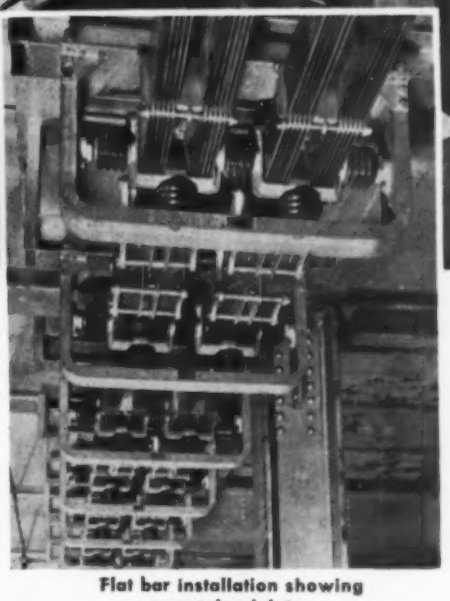
The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO

Also Manufacturers of — SAWING • CRUSHING • PULVERIZING AND MIXING EQUIPMENT • BILLET INSPECTION TABLES
DUST PUG MILLS • SINTER PLANT PUG MILLS

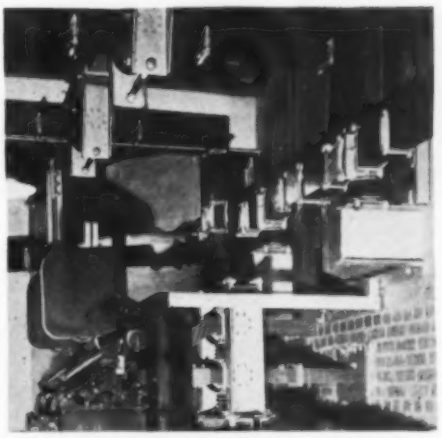
Heavy short circuit stresses will destroy inadequately supported bus structures and disrupt entire electrical installations. You don't risk such a disaster when you install Delta-Star reinforced bus structures engineered to withstand these stresses.

Delta-Star prefabricated reinforced bus structures are designed and furnished complete to the last detail. Heavy steel assemblies, high quality wet process porcelain members used in compression to take advantage of their greatest strength, and careful engineering and fabrication assure a structure you can depend on.

Our engineers will be glad to discuss your bus problems and work out a layout to suit your special requirements. Prefabricated open or enclosed bus structures are available for aluminum or copper bar, tubing, structural and special shapes; indoor or outdoor service.



Flat bar installation showing expansion joint.



Typical arrangement of motor or generator circuit-breaker sections.

OTHER DELTA-STAR PRODUCTS
Used in Mills and Industrial Plants

- Crane Rail Supports
- Disconnecting Switches
- Terminators (Potheads)
- Plugs and Receptacles
- Spool Insulator Cable Supports
- Water Cooled Conductors and Fittings
- Interrupter Switches
- Power Connectors

DELTA-STAR ELECTRIC COMPANY

CHICAGO 12, ILL.

DIVISION OF H. K. PORTER COMPANY, INC.

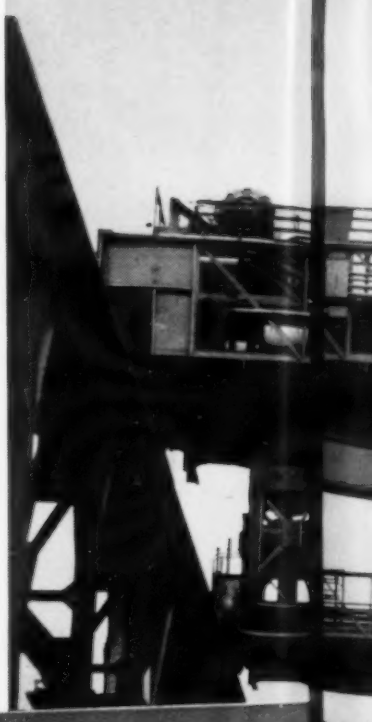
DISTRICT OFFICES IN PRINCIPAL CITIES

Cranes Built to AISE

Cleveland Steel Mill Cranes Meet or Exceed *ALL* AISE Specifications

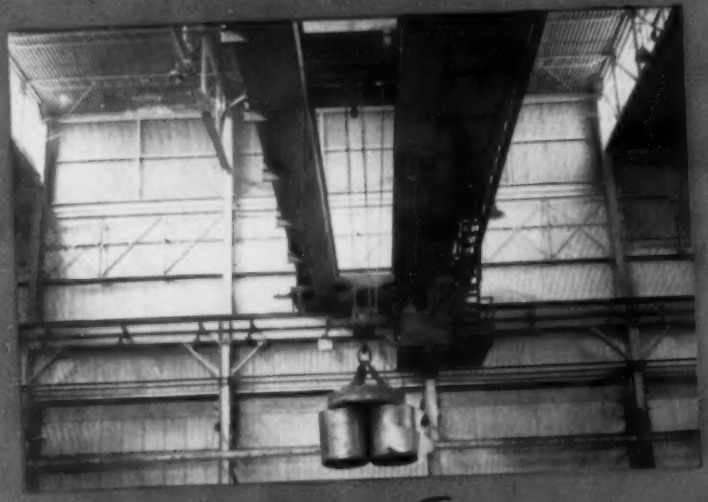
● For many years Cleveland Crane has worked closely with the Association of Iron and Steel Engineers and the Steel Industry in the drafting of overhead crane specifications that adequately cover the hard requirements necessary for proper mill performance.

Cleveland knows the "specs" and designs mill cranes in accordance with them. All Cleveland mill-type cranes meet or exceed AISE Specifications for Electric Overhead Traveling Cranes for Steel Mill Service.



THE CLEVELAND CRANE & ENGINEERING CO.
1131 EAST 289TH ST. WICKLIFFE, OHIO

10 Ton, 100'-0" Span Magnet Crane



Four 15 Ton, 120'-0" Span Cranes

SOME OF THE MILLS BEING SERVED BY CLEVELAND ALL-WELDED MILL-TYPE CRANES

Allegheny Ludlum Steel Corporation
Atlantic Steel Company
Brazilian National Steel Co.
Carnegie-Illinois Steel Corporation
Continental Steel Corporation
Crucible Steel Company of America
Ford Motor Company
Geneva Steel Company
Jones & Laughlin Steel Corporation
National Tube Company
Pittsburgh Steel Company
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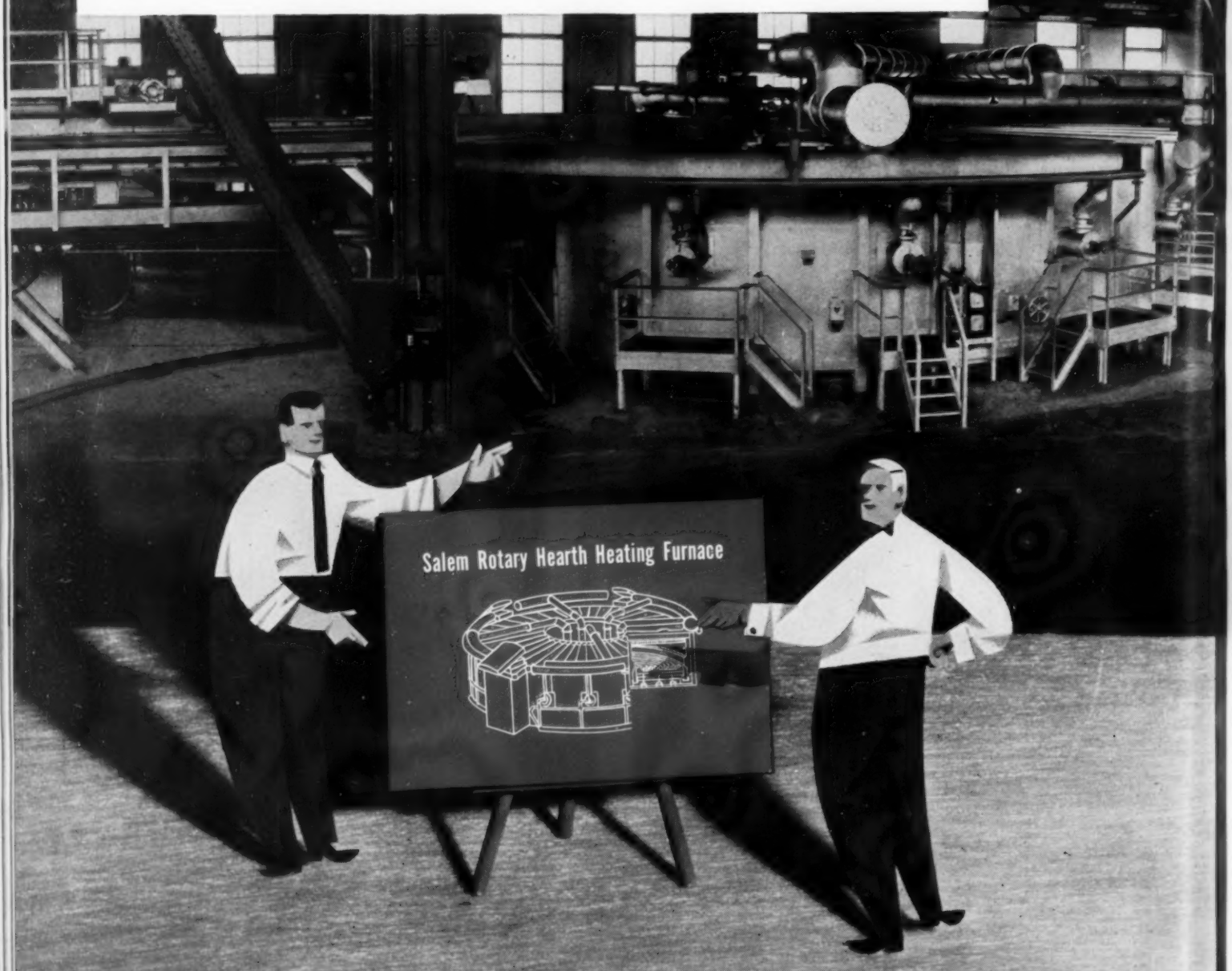

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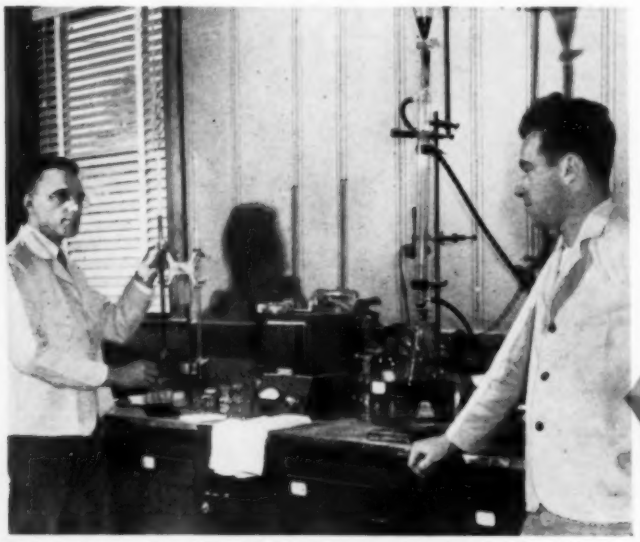

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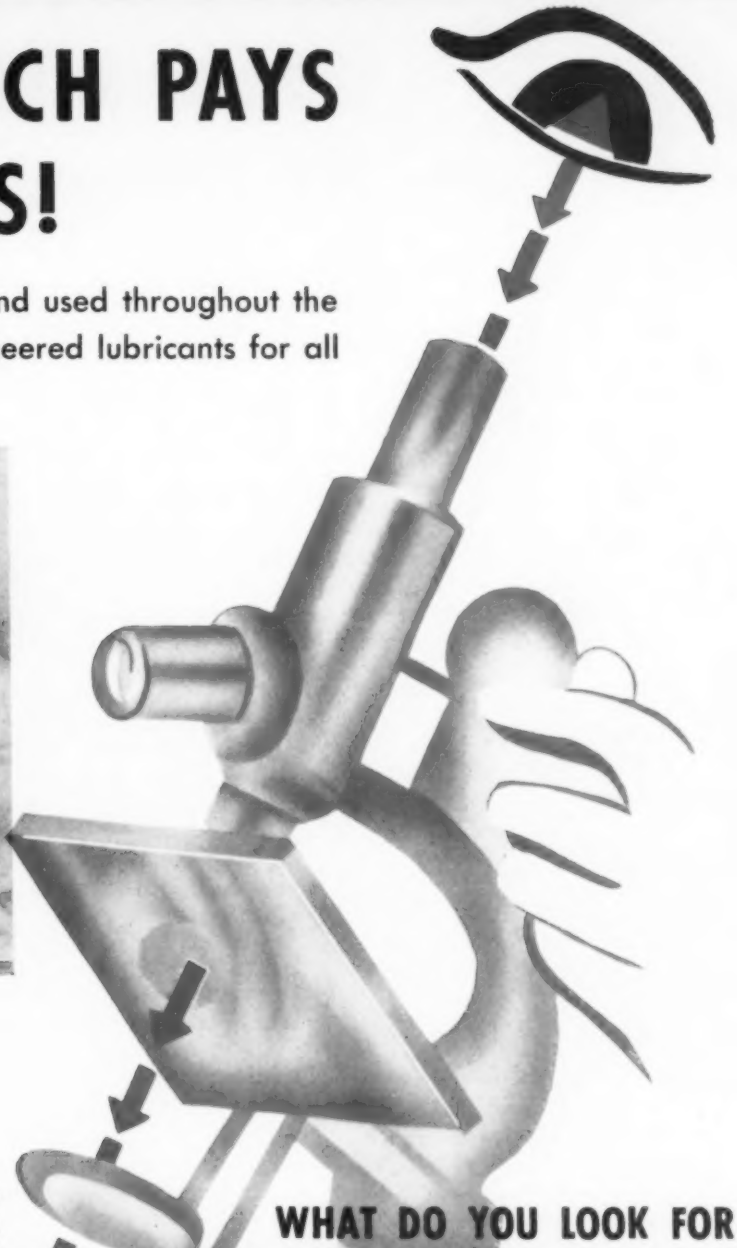

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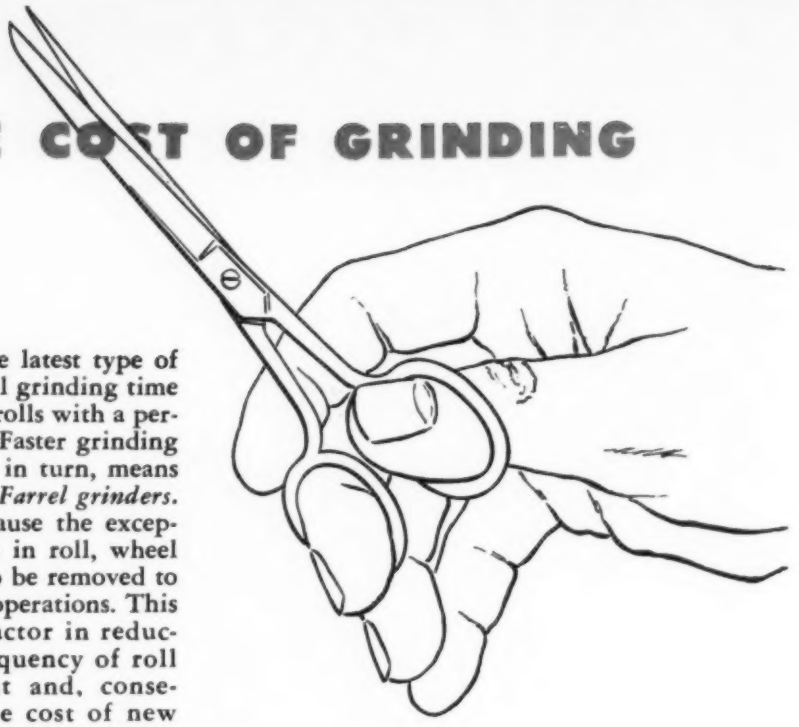

Reports from users indicate that with the latest type of Farrel machines they are able to reduce roll grinding time substantially, and at the same time obtain rolls with a perfect surface free from marks of any kind. Faster grinding means less labor per roll ground, which, in turn, means *you cut the cost of grinding when you use Farrel grinders.*

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THE various expansion projects at 118 plants in the iron and steel industry, calling for a total expenditure of $1,900,000,000, have received five-year amortization certificates for 60—85 per cent of their cost. In general, finishing facilities were given lower percentages than were given to basic producing facilities. For the time being, however, the rush has been stopped by Defense Mobilization Director C. E. Wilson's clamp-down on certificates of necessity and government loans until the overall situation can be carefully analyzed.

▲

GOVERNMENT agencies declared a buyer's strike to force tin-producing countries to lower prices for that commodity, which have increased 150 per cent since the outbreak of Korean hostilities. The Senate Preparedness Subcommittee urged that purchasing be held up until the "gouging" of American taxpayers by tin mine owners and speculators stops.

It would be nice if the government itself stopped "gouging" the taxpayers, and instead, trimmed out the non-defense pork barrel items from the budget.

▲

ALL-RAIL shipment of iron ore from the ranges to the consuming centers has been termed uneconomical, only to be used as an emergency measure. The rail strike and severe weather combined to hold such shipments to about 65 per cent of the 2,000,000 ton goal. All-rail shipments may have to be resumed next winter, however, unless carriers bring down well over 80,000,000 tons this shipping season.

▲

BETHLEHEM Steel Co. has received the first cargoes of iron ore from its newly developed deposit in Venezuela. Almost simultaneously, Bethlehem announced plans to develop a recently discovered deposit at Morgantown, Pa.

▲

A UNIVERSAL complaint nowadays is having too much month left over at the end of the money.

▲

BORON steels, brought out during World War II and then dropped because of customer's resistance, are coming back into the picture. Boron may reduce consumption of nickel, chromium and molybdenum one-half, but its action is as yet unpredictable. Five companies are now each making two heats of boron steel which will be thoroughly tested in order to learn more about the behavior of the material.

CASE Institute of Technology reports that 75 per cent of its 1951 graduating class have already received offers of employment, with salaries averaging more than $300 a month. The range of salaries offered has been $275—$525 per month. Just like old times!!

▲

ACCORDING to the Bureau of Mines, we need not worry too much about manganese, although it may become expensive. In addition to imports from India, South Africa and South America, we have the lean domestic ores and our slag dumps. Processing the lean ores and the slag will bring higher costs, but the Bureau believes their process for the treatment of basic open hearth slag may be ready for commercial use in about a year.

▲

A LOT of people stop looking for work when they get a job.

▲

CLAIRTON plant of United States Steel Co., long a producer of coke from 100 per cent high volatile coals, has started the use of about 20 per cent of low volatile coal to improve coke structure, permitting harder driving of blast furnaces, with consequent increase in iron production.

▲

THE fact that women devote so much time to figures doesn't mean they are good at mathematics.

▲

SPEAKING before a group of Carnegie Tech alumni in Pittsburgh, James J. Munns, vice president of Weirton Steel Co., who recently completed a round-the-world trip, says that a major war is highly improbable this year. He also stated that in general, the people in foreign countries do not dislike Americans to the extent that various dispatches and articles would lead us to believe, but that many politicians try to stir up such resentment.

▲

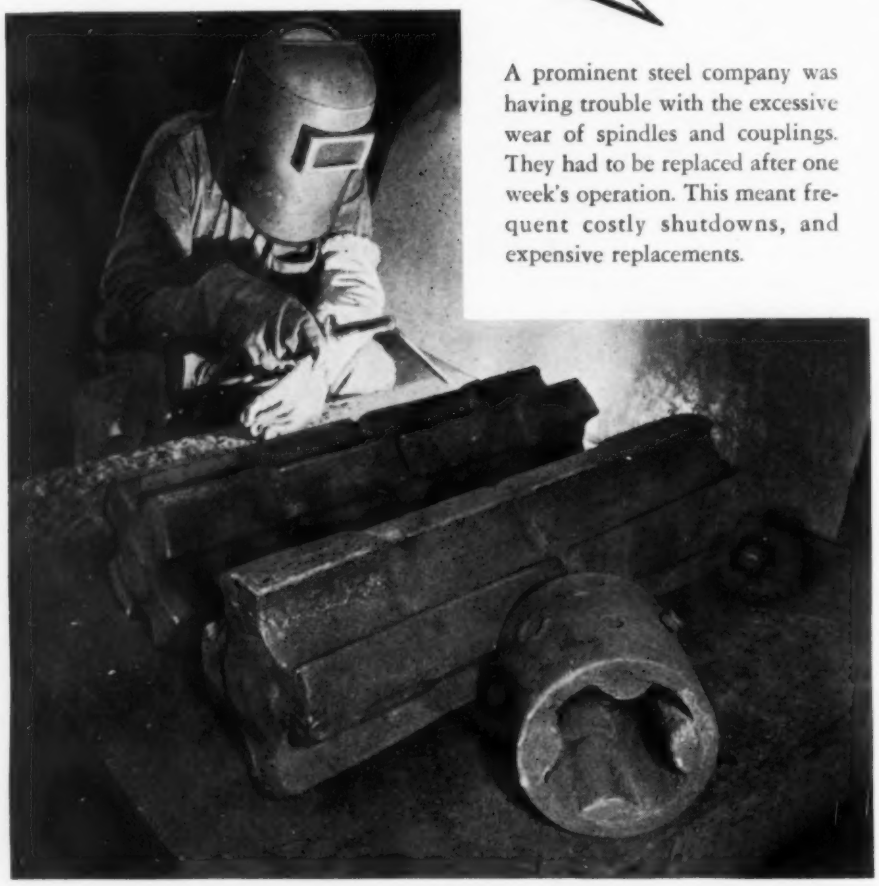
PEOPLE are too prone to form opinions and take action without considering the other fellow's viewpoint. For example, in this sophisticated age, the rabbit's foot has lost much of its significance, but don't forget it's darned important to a rabbit.

▲

ONE of the leading publishers of technical books claims that engineers do not read to any considerable extent. This statement is based on the fact that many technical books do not sell out the original printing of perhaps 3000 copies. In one way this seems odd, as engineering training uses books to a considerable extent. On the other hand, perhaps this is a reaction from the long educational period spent with books. We have known many technically trained men who became rather disdainful of books after they had gained practical experience and progressed to higher jobs. Or it may be that closer contact with actual engineering developments, either on the job or in current technical journals, brings realization that technology is always ahead of the printed page, and a technical book must be slightly out of date when it comes from the press.

There are, however, many books constantly published that can be of great help to steel plant engineers and operators. Managements might find it profitable to set up definite procedure to keep abreast of new books and urge their men to read them.

HARDFACING lengthens equipment life in steel mill... cuts "down" time... saves money



A prominent steel company was having trouble with the excessive wear of spindles and couplings. They had to be replaced after one week's operation. This meant frequent costly shutdowns, and expensive replacements.

J. J. Barry, Airco Technical Sales Service Specialist, was called in. He suggested hardfacing these parts with Airco No. 91 alloy. Service life of the spindles and couplings jumped to six weeks—a 600% increase in lasting power, with great parts-replacement savings and fewer shutdowns.

The mill was extremely pleased with these results and carried the economies of hardfacing to a wide range of steel mill equipment—roller guides, side mill guides, open hearth charging peels, sintering plant pug mill blades, dies, and hundreds of other similar parts... Airco's new line of Hardfacing Alloys were used throughout, and all produced savings that ran all the way from "highly satisfactory" to "amazing."

For more information about the reduced costs, increased efficiency, and steadier production made possible by hardfacing steel mill equipment, write your nearest Airco office. Ask them for your free copy of folder ADR-64: "Hardfacing Applications in the Steel Industry."

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More news about AIRCO steel mill processes

ACETYLENE SMOKING ELIMINATES HYDROGEN TRACES ON STEEL SURFACE

A leading steel mill, after experimenting on more than 2,000 molds of various sizes, plans to use acetylene ingot mold smoking in all molds that will be used for the pouring of "Tool Steels", "Electric Furnace Steel", "Acid Open Hearth Steel", and "Roll Foundry Steel". They claim that steel poured in molds—*and treated in any other way than by acetylene smoking*, show traces of hydrogen in the surface of the steel.

THE ECONOMICAL WAY TO CUT HEAVY SCRAP TO CHARGING BOX SIZE

Today, Airco offers steel men outstanding oxyacetylene cutting methods for easy and economical handling of heavy scrap. Practically any heavy scrapping job can be handled . . . regardless of size, shape or location . . . with:

- **the oxyacetylene torch, plus oxygen lance.** Buttons, ingots, and similar large chunks can be cut to size in any position without initial handling.
- **machine gas cutting.** Where crane facilities are available, this set-up is ideal. All it requires is a heavy-duty cutting torch mounted on a standard Airco No. 40 Radiagraph or a Travograph.
- **the oxygen lance.** Where extremely large sections, such as open hearth spills and huge ingots are to be cut, the oxygen lance should be used.

All this is just another example of how modern Airco oxyacetylene equipment is helping steel mills slash time and costs.

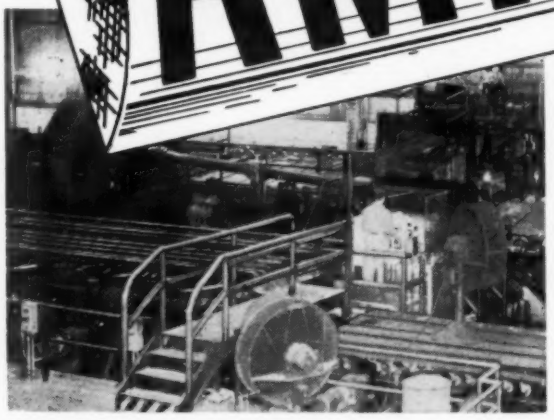
★ ★ ★

Air Reduction supplies Oxygen, Acetylene and other industrial gases . . . Calcium Carbide . . . and a complete line of gas cutting machines, gas welding apparatus and supplies, plus arc welders, electrodes and accessories. Ask us about anything pertaining to gas welding and cutting, and arc welding . . . we'll be glad to help you.

At the Lorain Works of National Tube Company

Ampco Metal is specified for a variety of jobs where its high resistance to pressure, shock, and fatigue pays off in long-wearing economies. Shown here is one of 8 Ampco Grade 18 guides which take the lateral pressure of the top roll on the No. 4 Blooming Mill illustrated below.

Ampco-Cast-to-Size Slippers are furnished +1/32"—0" or —1/32"+0" tolerance with oil grooves "cast-in" to requirements. Accurate surface finishes eliminate necessity for machining.



Grade 18 Ampco Cast-to-Size Slippers are used in *(Above)* the Universal Joints of this seamless piercing mill at the Lorain Works.

(Below) in the same piercing mill Ampco Grade 18 internal and external nuts are used for height adjustment controls.

stands up longer in steel mill service...

Yes, Ampco Metal is a "tough customer." It has to be—to take the terrific beating of steel mill pressure loads, shock, and fatigue. You can't beat it for rugged wear-resistance. That's why more and more mills (like the Lorain Works) specify Ampco Metal to cut maintenance service, downtime, replacement costs, and production losses.

Protect your production schedules. Insist on wear-resistant Ampco metal (aluminum bronze) for wear plates, slippers, screwdown nuts, flash welder dies, pickling equipment — and other proven spots where Ampco's extra toughness pays off in reduced costs.

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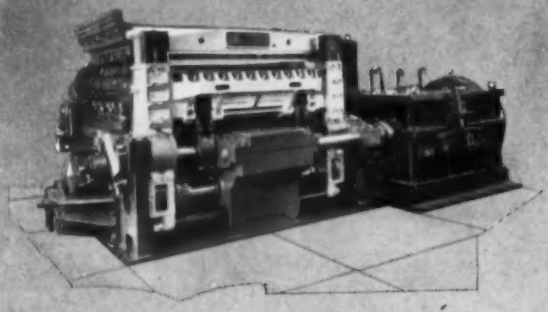

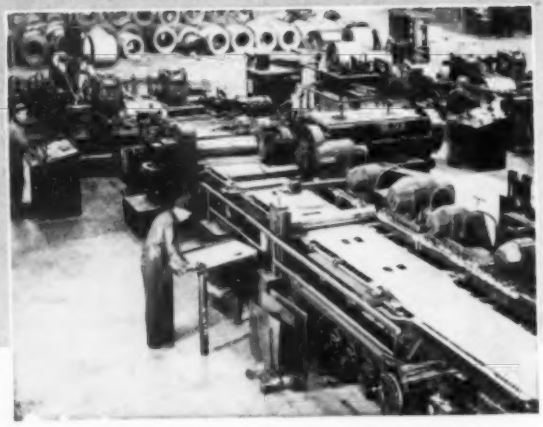

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Iron AND Steel ENGINEER

APRIL, 1951 VOLUME XXVIII NUMBER IV

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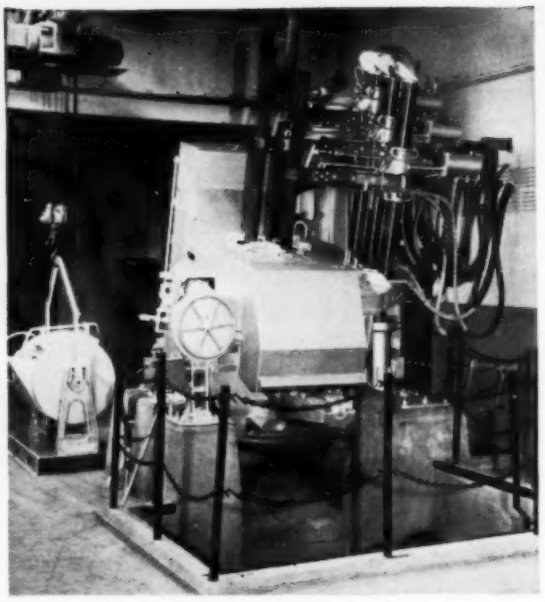

This Lectromelt Furnace, rated at 1,000 pounds per hour, is used on manufacturing development work at the new International Harvester Company Laboratories, Chicago.

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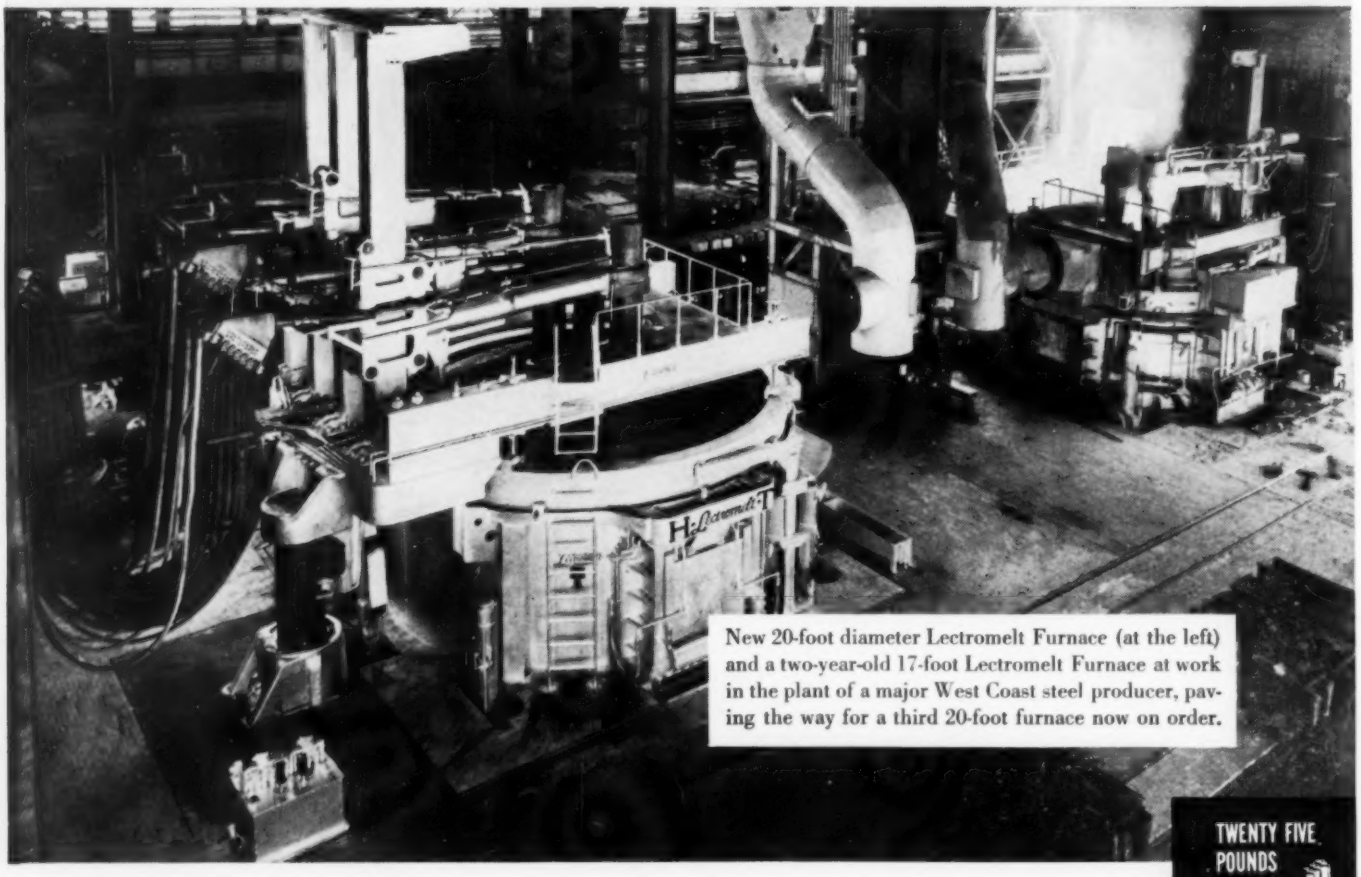


New 20-foot diameter Lectromelt Furnace (at the left) and a two-year-old 17-foot Lectromelt Furnace at work in the plant of a major West Coast steel producer, paving the way for a third 20-foot furnace now on order.

WHEN YOU MELT... MOORE RAPID Lectromelt

The Continuous Seamless Pipe Mill

By JOHN L. YOUNG
Vice President-Engineering*
National Tube Co.
Pittsburgh, Pa.

JOHN L. YOUNG

. . . . the new mills at National Tube Co.'s Lorain plant set a new high in units designed for economical production of seamless tubing . . . .

▲ AT the outset it may be well to define the use of the word "continuous." We have heard of continuous rod mills, strip mills, plate mills, etc. The term as applied to rolling mills in the steel industry generally means the completion of one or more phases of the manufacturing process by the continuous passage of the work through the several increments which make up the complete phase. This is in contrast to the older method of production in which the work was given several passes through a single stand or mill.

Previous to 1926, when the first continuous strip mill was built, sheet and plate had been made in relatively short lengths. The advent of the continuous mill permitted the production of strip from which many individual lengths of sheets or plates could be cut.

The continuous seamless pipe mill follows the same general pattern and the product might be considered as a seamless cylindrical strip. Seamless pipe generally has been produced in individual lengths. The application of the continuous principle to the new seamless mill permits production of seamless pipe in multiple lengths and at substantially constant tonnage regardless of diameter or wall thickness.

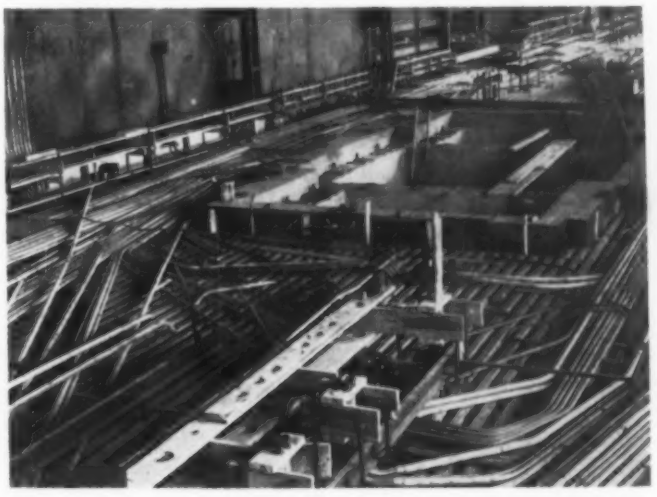
Based on the premise just outlined, this mill has been called the first continuous seamless pipe mill. It should be pointed out that mills utilizing one or two of the various steps employed in this process have been built and are in operation both in this country and abroad. However, the new mill at Lorain is the first installation in which all of these developments are combined into one operating unit.

The Foran mill at the Globe Steel Tubes Co. in Milwaukee, Wis., has employed the rolling-on-the-bar unit for a number of years, and mills of the same general type are in operation in Anzin, France, and Liege, Belgium. A mill similar to the European installations was in operation at the Ellwood City plant of the National Tube Co. a number of years ago.

The tension reducing mill (sometimes called stretch mill) is strictly a National Tube Co. development.† The original production unit, installed at Lorain works a number of years ago, is still operating as a component part of the No. 5 Buttweld unit. During the war, a larger and improved tension reducing unit was built and installed in conjunction with the revamping of No. 2 seamless mill at National Tube Co.'s works at Gary, Ind. Operation and experiments with these two mills provided the information and basic knowledge utilized in the design and construction of the tension reducing mill on the No. 4 seamless mill at Lorain works.

Experimental data and a description of the principles involved in tension reducing mills were covered in detail in a paper delivered by Stevenson Findlater at the 1946 Annual Convention of the Association of Iron & Steel Engineers in Cleveland, which was published

Figure 1 — Underlying the floor of the new mill is a mass of conduit.



*Now Vice President - Chief Engineer, United States Steel Co., Pittsburgh, Pa.

†Patent No. 1,888,607.

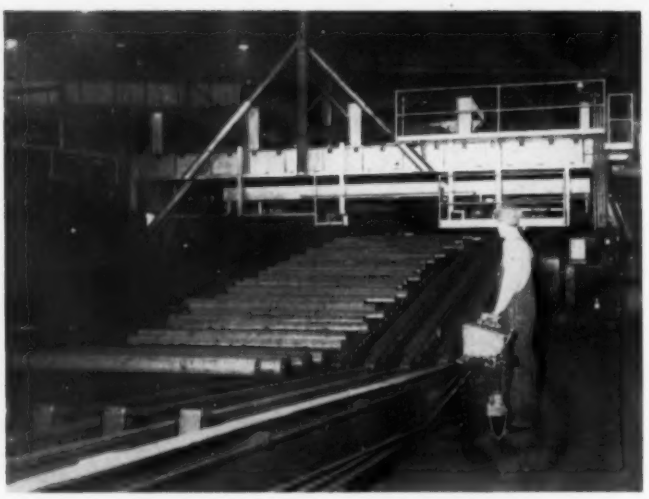


Figure 2 — Billets move up charging table into the rotary furnace.

in the February, 1947 issue of the *Iron and Steel Engineer*.

The new mill at Lorain works has a rated capacity of 18,000 tons per month in the size range of 2 to 4-in. pipe. The 2-in. pipe is delivered from the 12-stand tension reducing mill in 142-ft lengths at a maximum speed of 1300 fpm.

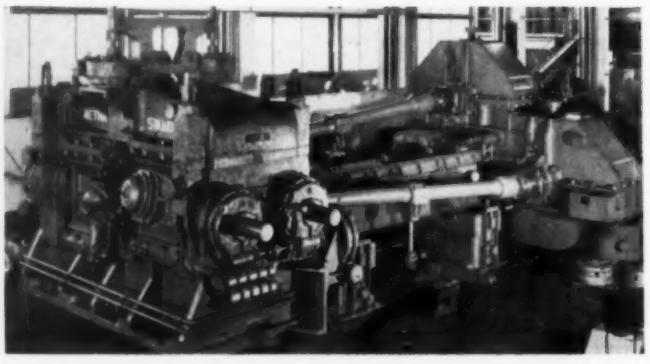
The outstanding feature of the mill is that only one size of round billet is required, regardless of the size of finished product. All sizes to be produced from 2 to 4-in. pipe will be produced from a single billet diameter weighing one-third of a ton. This means that regardless of pipe size being produced, the tonnage rate of the mill is substantially constant, or approximately 40 tons per hour.

It must be emphasized at this time that the type of continuous mill discussed here is only economically feasible where there is a large demand for a small range of sizes.

You will note that this mill produces only a small range of sizes of pipe from 2⅜ to 4½ in. outside diameter. The fact that its economic value depends upon a stretch reducing process does not enable us to say that larger sizes could be as successfully produced. Very little, if any, experimentation has been done in stretch reducing larger sizes of pipe, and it will probably be some years before the upper limitations of the process are determined.

Mill operation is almost completely automatic. The

Figure 3 — This shop view of the piercing mill shows the details very clearly of the mill inlet table and drive.



furnace charging machine, which is in alinement with the furnace charging conveyor, is completely automatic and is synchronized with the rotation of the furnace, both of which can be manually controlled by the discharge machine operator.

From the time the billets are placed by electric overhead traveling crane on the charging skids at the furnace, there are only four manual operations involved in the process until the cooled cut-to-length hot rolled tubes arrive at the pilers.

The first of these manual operations is discharging the billets from the rotary hearth furnace. The operator of the discharging machine, by means of a single joy-stick control, alines the discharge peel with the heated billet to be removed, grips the billet, elevates it, withdraws it, and deposits it on the skids from which it is automatically conveyed and delivered to the piercer inlet table.

The second and third manual operations are at the piercing mill where the piercer operator and plugger are stationed. By remote control from a pulpit, the operator

Figure 4 — Top view of 9-stand continuous mandrel mill shows roll housings, housing supports and shoes. The roll diameter is 25 in.

introduces the heated billet into the piercer rolls and removes the pierced billet from the outlet table. The piercer plugger installs a new piercing point and removes the used piercing point after each operating cycle. It might be stated that methods are now being investigated which may eliminate the necessity for installing and removing piercer points at such frequent intervals.

From the time the pierced billet is ejected from the piercer outlet table, the entire tube-making cycle is completely automatic and synchronized until the cooled finished-to-size tube arrives at the straighteners. The introduction of the tube into the straightening machine accounts for the fourth manually controlled operation.

After straightening, the tubes are automatically conveyed and delivered to the automatic disc cutter type cut-off machines.

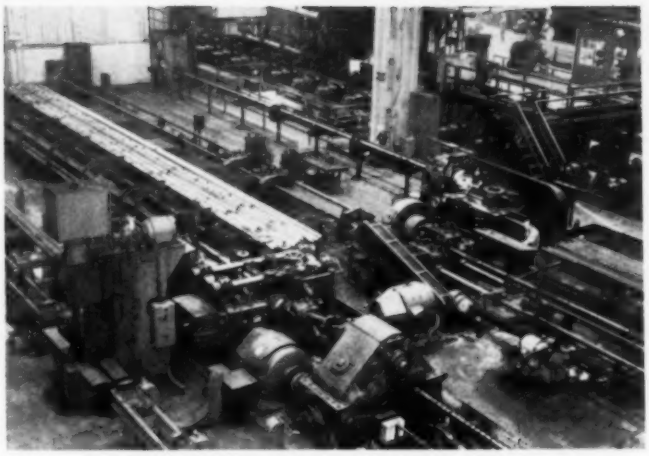


Figure 5 — This view of the bar conditioning department shows bar turning machine, two roll straighteners and end turning lathe.

It may be well to state that operators are stationed at control points which permit the automatic cycling to be converted to manual push button control in case of difficulty.

The sequence of operations in processing the round billet into a tube is as follows:

1. Heating the round billet.
2. Piercing the billet.
3. Inserting the mandrel through the pierced billet, reducing the outside diameter and wall in the rolling mill, after which the mandrel is removed.
4. Reheating and tension reducing the rolled tube to final size.
5. Middle cutting and cooling the tubes before rotary straightening.
6. Cropping and cutting into multiple lengths.
7. Stocking.
8. Finishing.

In the production of seamless pipe, the first major and a most important operation is the uniform heating of billets before piercing. In the past, the round billets were generally heated in a long furnace with sloping hearth, in which it was customary to manually roll the rounds from the charging end to the point of discharge. Not only was the labor involved in this operation expensive, but because manual movement of billets was required, irregular movement resulted, causing lack of even temperature distribution in the billet — so vital to wall uniformity in the finished product.

Figure 6 — The mandrels after stripping are placed on a cooling transfer.

To overcome these objectionable features, a rotary hearth billet heating furnace, with a rated capacity of 75 tons per hour, was installed at the new seamless mill at Lorain works. In this furnace the hearth, which is 80 ft-0 in. in outside diameter and 18 ft-0 in. wide, rotates on wheels. The charging and discharging doors are in close proximity. Cold billets are placed on the hearth, which, after rotating through approximately 340 circular degrees, delivers them to the discharge opening, uniformly heated and at proper piercing temperature. As previously mentioned, mechanical manipulators are employed in charging and discharging the round billets. The rotary hearth furnace was discussed in a paper entitled "Design and Performance of Large Rotary Furnaces" presented by A. F. Kritscher at the 1949 Spring Meeting of the Association of Iron and Steel Engineers and published in the February 1950 issue of the *Iron and Steel Engineer*.

The mannesmann type piercing mill, which is powered by a 4500 hp synchronous motor, has 42-in. rolls which rotate at 101 rpm. In a horizontal plane, the axes of these rolls converge toward the outlet at an included angle of 15 degrees. The roll chocks are provided with anti-friction bearings and hold the rolls at a fixed feed angle of 10 degrees. A tube hollow, 5¾-in. diam × 24 ft-0 in. long is produced. The operation of a mannesmann type piercer has been described in a paper entitled "Modern Seamless Tube Mills" by William Rodder, presented at the 1946 AISE Annual Convention, and in a paper entitled "Factors in the Operation of a Mannesmann Piercing Mill" by H. R. McLaren, presented at the 1947 AISE Annual Convention. These articles were published in the April 1948 and May 1949 issues of the *Iron and Steel Engineer*.

Figure 7 — Pipe is leaving sizing mill and entering transfer tables.

The tube hollow is kicked out of the piercer outlet trough and rolls into position on the mandrel mill approach conveyor, where the lubricated mandrel is automatically inserted, and the tube with the inserted mandrel enters the continuous rolling mill.

The continuous rolling or mandrel mill, as it is called, consists of nine tandem, individually powered stands of

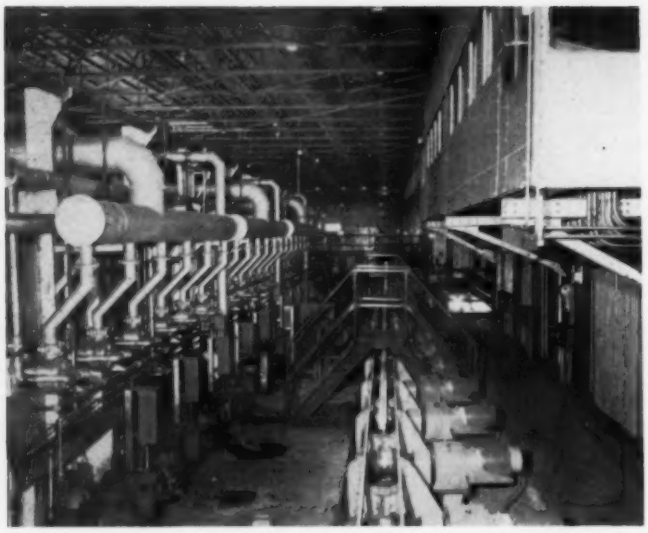


Figure 8 — Conveyor is delivering the sized pipe to the cooling conveyor.

Figure 10 — The 12-stand stretch reducing mill is located very close to the furnace.

2-high grooved rolls, 26 in. in diameter. The roll stands are mounted with their axes at 45 degrees from the vertical and with consecutive stands having their axes at 90 degrees to one another. The motors driving these roll stands aggregate 8500 hp.

In the first two roll stands, the diameter of the pierced billet is reduced so that the inner surface is in substantial contact with the mandrel bar. Each of the next two stands makes a reduction in wall over a portion of the circumferences, the two jointly completing the first increment of wall reduction. The next two stands — the fifth and sixth in this mill — make a similar complete reduction by somewhat lesser magnitudes. The next two succeeding stands (7 and 8) are designed to effect a very slight reduction, the purpose of which is to planish the tube surface. The shape of the tube, which has been oval in the preceding stands, is changed to circular section in the ninth stand. The rounding up operation effected by this stand frees the inner surface of the tube from the mandrel bar to facilitate its withdrawal.

This mill will deliver a 65 ft-0 in. tube length at rates up to 900 fpm. The overall wall reduction effected in the mandrel mill is approximately twice that now made in the conventional 2-high plug mill.

The mandrel bars for the continuous rolling mill, which are 63 ft-0 in. long, are rolled on the new blooming, bar and billet mill. The ends of these bars are machined in a lathe, after which the entire surface is turned and polished.

After automatic withdrawal of the mandrel bar by the chain stripper, the rolled tubes are reheated before they are processed either in the tension reducing mill or the sizing mill.

The tension reducing mill consists of twelve stands, 14-in. diam, 2-high overhung rolls on 14½-in. centers. Each stand is individually driven by a 200 hp motor. Tension reducing is unique in that without the use of a supporting mandrel, the wall thickness of the tube is maintained or reduced simultaneously with the reduction in diameter. This operation differs from the conventional reducing mill, in which the wall thickness of the tube is increased as the diameter is reduced. In the tension reducing mill the tension forces, to which the tube is subjected between roll stands, are not only effective in reducing the wall thickness of the tube but,

Figure 9 — In the background is shown the reheat furnace and in the foreground is the stretch reducing mill.

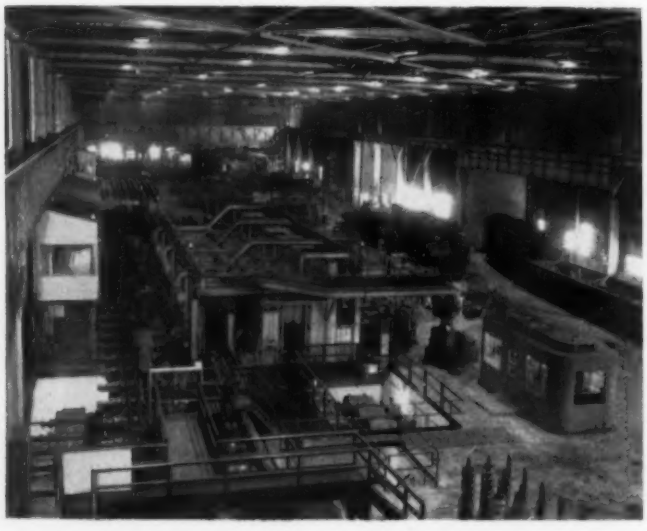
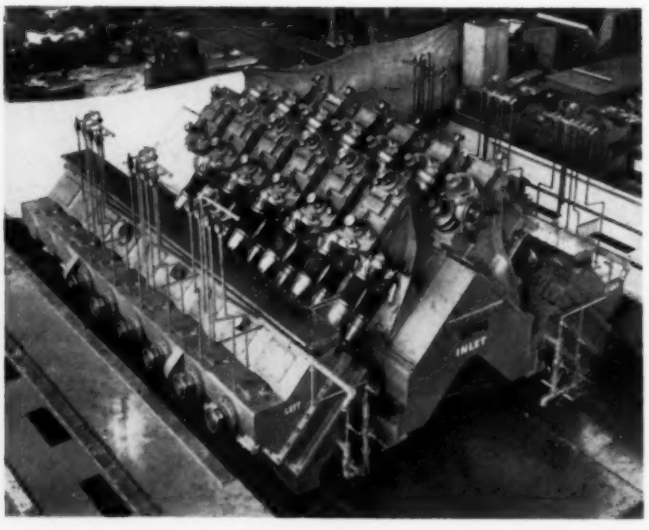


Figure 11 — Shop view of 12-stand stretch reducing mill shows the motor bases.



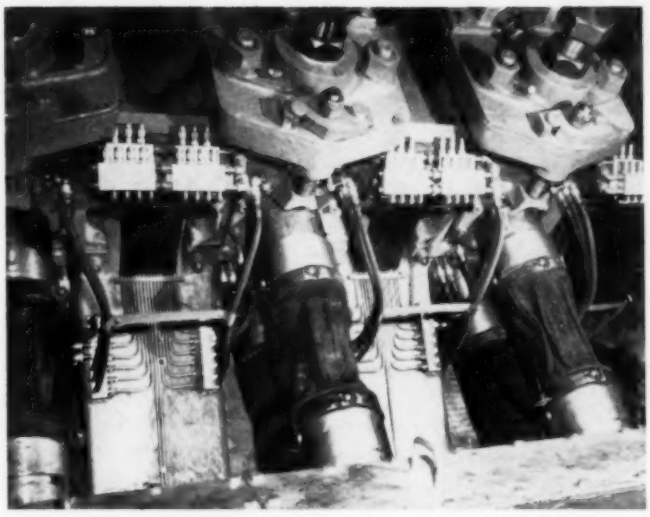


Figure 12 — An elaborate grease lubrication system was installed on the 12-stand mill.

Figure 14 — The cradles at the end of the discharge conveyors expedite delivering batches of pipe.

in addition, make possible diameter reductions in successive stands more than 20 per cent greater than can be made in a conventional mill. The ability to maintain or reduce the entering tube wall while large diameter reductions are being made in successive stands permits a single entering tube outside diameter size to be employed for the production of all pipe sizes in the range, 4 to 2 in. Pipe diameters over 3 in. are brought to final dimensions in the sizing mill.

Chain type cooling beds permit the tubes to be cooled as they are conveyed to the two 3-roll straightening machines.

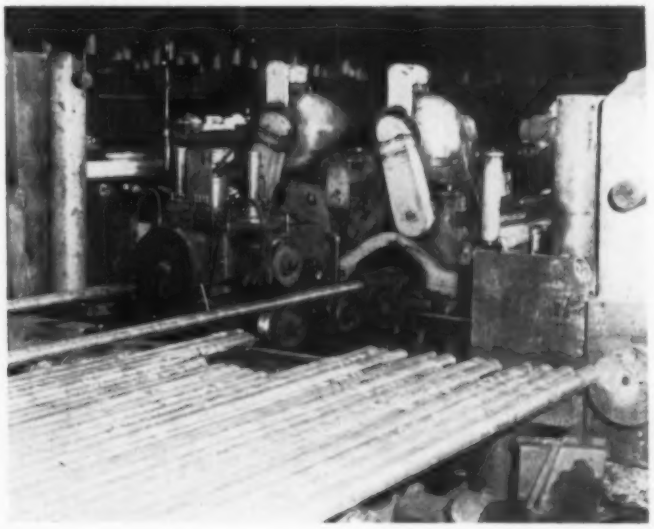
The rotary disc cut-off machines are of new design. The tube is held at stationary while the rotating heads, each of which carries three 7-in. diameter idler disc cutters, rotate continuously as the cutters are hydraulically forced toward the centerline of the machine to sever the pipe wall. Each of these machines is a double unit, with two cutter heads. There are four cutter heads in the two units. The heads rotate at approximately 300 rpm and make it possible to reduce the actual cutting time on 4-in. standard pipe to less than two seconds. These machines have been designed to measure and cut automatically a predetermined length of crop from the end of the tubes, after which the remaining length is automatically measured and cut into multiples which are delivered to the pilers. From the pilers, the cut-to-length tubes are removed by overhead crane and placed in stock racks.

The finishing floor consists of three lines. Two of these lines are equipped with facing and chamfering units, threading units, automatic coupling screwing-on units and automatic testing units, to accommodate pipe lengths up to 50 feet. The third unit, having no threading or coupling screwing-on machines, will accommodate pipe up to 65 ft-0-in. lengths. All units are equipped with dual heads and the control is so arranged that operations may proceed on either of the dual heads, the other one becoming available for adjustment or tool replacement, although they are both normally operated as a unit. Each of the three lines accommodates pipe sizes of 2 to 4 in., and each line has been designed with a finishing rate on 2-in. pipe of 420 pieces per hour.

A novel arrangement for control of the automatic handling tables and finishing machines on these three lines is that a "tell-tale" board has been provided which

Figure 13 — The plant is well equipped with cooling conveyors.

Figure 15 — The plant has two pair of disc cut-off machines.



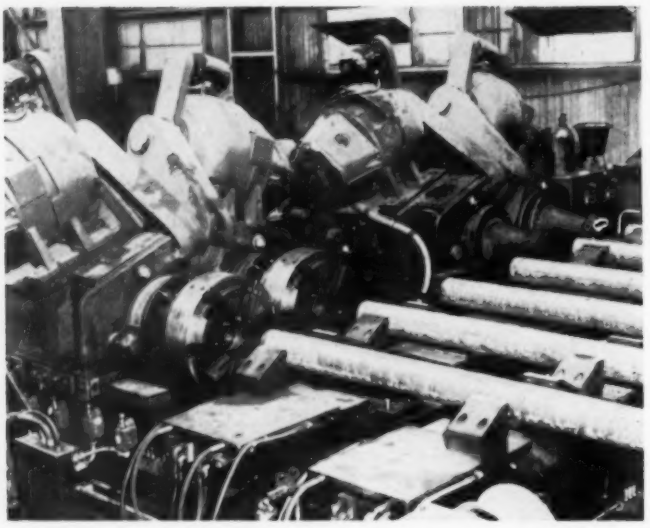


Figure 16 — The double spindle chamfering and threading units reduce costs in pipe preparation.

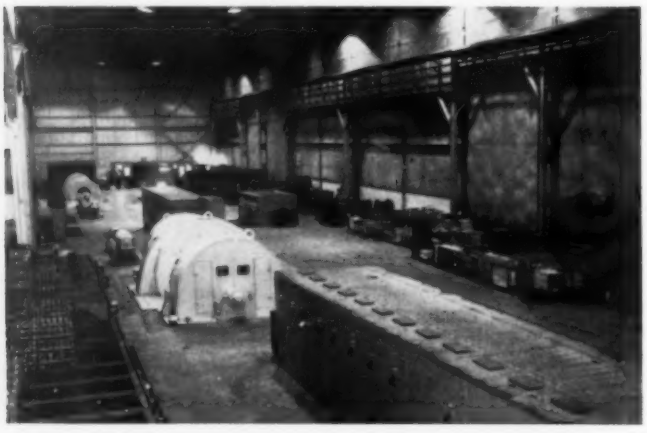
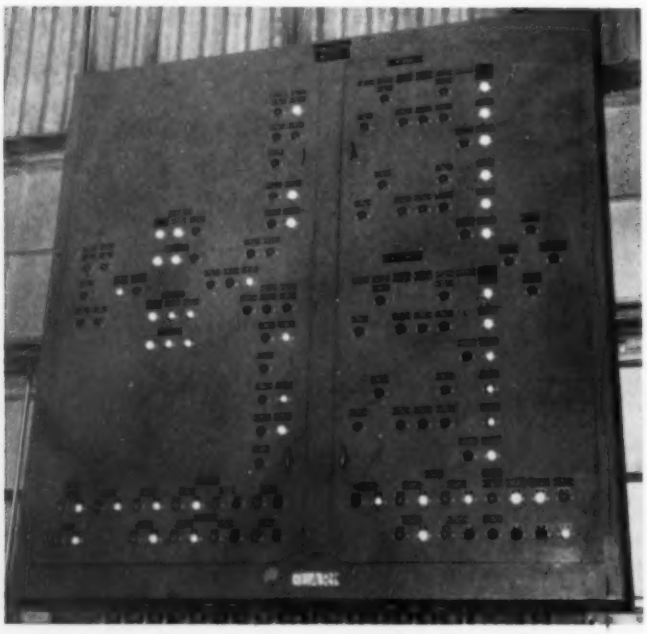


Figure 17 — The general motor room layout shows the 138-kv switch gear serving No. 4 seamless mill in the right foreground. A 6000-kw motor-generator set for the mandrel mill motors is shown in the center.

Figure 18 — The tell-tale board reduces delay time since it aids in quickly determining trouble sources when operation is interrupted.



causes a tell-tale light to become energized when each operation in the sequence has been completed. This provides the maintenance inspector with a very valuable tool in that it makes possible the immediate location of trouble when the cycle of operation is interrupted by a faulty limit switch, contactor, etc.

No. 4 continuous seamless pipe mill was placed in operation in January, 1949. The very first pipe produced proved that the principle was right and that the investment was justified. Since that time, production has been gradually brought toward the rated capacity. Like all new developments, there have been many heartbreaks and headaches in obtaining uninterrupted operation and rated production. Many new problems cropped up, mostly of a mechanical or electrical nature, but the process was sound. Back in 1945 when the development was merely an engineering study, it was estimated that it would take eighteen months to reach the anticipated production rate. That engineering prognostication proved only too true, but that is the penalty we must pay for progress.

The round billets for the seamless mills at Lorain works are rolled on the new blooming, bar and billet mills, which were described in a paper presented by A. F. Eisel at the 1950 Spring Conference of the Iron and Steel Engineers and published in the August 1950 *Iron and Steel Engineer*.

It may be well to mention that all of the new a-c equipment employs 60-cycle power whereas the old equipment was 25-cycle.

A second continuous mill was started at Gary, Ind., in January, 1950. It is basically the same as Lorain No. 4 mill except that the size range is smaller. As an alternate to the continuous rolling or mandrel mill, the Gary unit includes an Assel mill and a rotary sizing mill on which heavy wall tubing is produced. The Gary mill will be described fully in a future paper.

DISCUSSION

PRESENTED BY

WILLIAM RODDER, Vice President in Charge of Engineering, Aetna-Standard Engineering Co., Youngstown, Ohio.

H. R. McLAREN, Assistant General Superintendent, The Timken Roller Bearing Co., Canton, Ohio.

JOHN L. YOUNG, Vice President-Engineering*, National Tube Co., Pittsburgh, Pa.

BRYANT BANNISTER, Consulting Engineer, National Tube Co., Pittsburgh, Pa.

MARTIN L. GETTIG, Superintendent of the Seamless Tube Mill, Youngstown Sheet & Tube Co., Youngstown, Ohio.

G. E. BROCK, Acting Supervisor Engineering Department, Jones & Laughlin Steel Corp., Aliquippa, Pa.

PAUL E. FLAUTZ, Assistant Superintendent of Hot Mills, Pittsburgh Steel Co., Monessen, Pa.

*Now Vice President-Chief Engineer, United States Steel Co., Pittsburgh, Pa.

A. B. CAPRON, Superintendent of Tube Mills, Babcock & Wilcox Tube Co., Beaver Falls, Pa.

R. E. DEWEY, Chief Engineer, Ohio Seamless Tube Co., Shelby, Ohio.

W. Rodder: The basic idea of reducing the wall of the pierced seamless shell by rolling it in a multi-stand mill over a bar is quite old, just as the idea of rolling strip in a continuous mill was old.

The possible application of individual motor driven mill stands with proper synchronizing controls, also the development of precision bearings to take the high rolling pressure made both processes practical.

To overcome the hard manual labor and other disadvantages of the old conventional plug mill, other processes have been used for reducing the wall:

Push benches (mostly used in Europe).

Diescher mills.

Assel mills.

All these mills have inherent limitations which limit the production and length of tube to be produced.

For producing pipe and tubes in small diameter, long length and great quantities, the continuous type mill seems to be up to this time the ideal mill.

H. R. McLaren: This paper covers the Lorain continuous mill very well, and I am sure it will find a place in the files of the seamless men. I particularly like the definition of the continuous mill since I have heard many arguments by non-seamless people stating that the continuous mill was an intermittent process rather than continuous.

There are several points I would like to have cleared up:

1. Have you found the rotary furnace to perform as satisfactorily as you anticipated?
2. You mention that the piercer is so designed that the roll shafts converge toward the outlet and that the angle of conic is 15 degrees. This is just opposite to the method of operation of cone-type piercers. The original Assel elongators were installed this way and they operated so much smoother when the direction of rolling was reversed. Has there been any noticeable detrimental effect of this type of piercing?
3. What is the limitation of the rotary disc cut-off machines as far as wall thickness and hardness is concerned?

John L. Young: In answer to the first question about the rotary furnace, we made quite a study of the scale loss problem of such a furnace before purchasing, and I feel that when the mill is operating at full capacity we will reduce the scale loss from that now being experienced and reach our anticipated figure. I mentioned heartaches and headaches in my paper and those things have all come about through outages in the mill, which naturally has caused the scale loss to be rather high.

I might mention in passing that for the new continuout seamless mill at our Gary, Ind. works we have installed an entirely new type of continuous furnace for heating billets. That furnace will be described in detail in a paper in the near future. All I will say now is that it looks very good and very promising.

Bryant Bannister: To answer that question very shortly, the answer would be "no." There are no disadvantages that we have found in connection with the converging angle of the piercer roll. In fact, we think there are many advantages. One of them — we require less conditioning of the billets, so far as outside seams are concerned. We experience practically no outside seams with normally conditioned billets, which we attribute partly to the type of piercing we are using. The translatory efficiency of the piercer under consideration is undoubtedly higher than that of any other mill we operate. The outlet speed reaches three feet a second.

John L. Young: With reference to the third question about the limitation of the rotary disc cut-off machines, as far as wall thickness and hardness is concerned, I might state there has been no difficulty so far from hardness or from the thickness of pipe produced on this mill. In fact, the disc cutters are doing an excellent job.

The pressure on the knives can be adjusted hydraulically to take care of hardness or softness.

M. L. Gettig: The art of piercing with a so-called reducing pass is not new and was employed to a certain degree in the pilger method of pipe manufacture. The benefits of this method of piercing in relation to outside surface defects is readily apparent to those whose knowledge of piercing makes them realize that any inherent weaknesses in the steel would not be so severely stressed in the reducing pass as would be the case in an expanding pass. We, ourselves, have not had any great experience with this newer type of reducing pass and would be pleased to have any information Mr. Young may have available regarding the effect on inside surface of this type of pass. To be more explicit, is it possible to use steels with some segregation or even evidences of piping without having severe internal fracturing ahead of the point which would result in the pipe being scrapped?

With regard to rolling on a mandrel, this art also is not new and as stated by Mr. Young, has been used for a considerable number of years by at least one company in this country as well as in Europe. It has always been our understanding that the mandrel cost on this type mill was extremely high and we are wondering whether or not Mr. Young's company has been able to develop mandrel materials which are sufficiently economical for use in this type of rolling.

In regard to the tension reducing mill, otherwise known as the stretch mill, it is our understanding that this type of mill results in considerable thickening on the ends of the pipe. This we further understand is the result of non-uniform pull as the pipe enters the mill in one case and as the pipe leaves the mill in the other case. If there is any information available on cut-off yields from this mill, we would be pleased to learn the effect of this heavy wall.

We were very interested in the rated capacity of this mill which has been quoted at 18,000 tons per month. This is an ideal set-up from a hot mill point of view. From an economical finishing point of view, it seems to us that an enormous capital investment would be required to finish 18,000 tons of 2-in. pipe. A large part of this investment would lay idle while processing 4 in. outside diameter. It is further our understanding that an increase in size range down to ½ in. is eventually considered. It would appear that the finishing investment required for 18,000 tons of ½-in. pipe per month would be out of all reason. We realize that through

scheduling, it will be possible to run part months on various sizes, but if insufficient equipment is provided to take peak loads, then an enormous project of stocking and warehousing unfinished pipe will be necessary. We are wondering wherein lays the happy medium which will keep down the capital investment without unduly increasing processing and stocking costs.

We are further interested in the small number of manual operations required for the mill operation. Being that we are also somewhat automatic minded, we believe that one or two more of the four manual operations could be made automatic.

We were also particularly interested in the disc type rotary cut-off machines and would be pleased to learn what experience National has had with these cutters when used on the harder grades of steel such as the D and E grades of drill pipe and the J and N grades of tubing and casing.

John L. Young: Mr. Gettig's first question referred to the inside surface of the pipe produced from the new type of reducing pass. I think the best way to answer that question is to state that the pipe coming off this mill, both externally and internally, is excellent.

Your second question refers to the development of mandrel materials which are sufficiently economical for use in this type of rolling.

I think we have just about overcome the mandrel problem as to the type of steel and lubrication. We are now getting around 2000 to 2500 pieces per mandrel before redressing. The steel now being used is a low alloy.

The third question refers to the crop end loss from the stretch reduced pipe.

Naturally, the stretch reducing process automatically leaves heavy ends, and in order to make the process economical, long lengths are necessary. At the present time the crop ends are longer than our original estimates but gradually experience is cutting down the crop lengths. Furthermore, it must be taken into account that the mill is completely automatic, including the cut-off machines, and as there is always a slight difference in billet weight, the minimum weight billet determines the minimum length of crop.

The next question refers to the happy medium of capital investment. I thoroughly concur with Mr. Gettig's statement that the finishing investment required for 18,000 tons of ½-in. pipe per month would be out of all reason, but of course, the order pattern does not run that way and there must be a balanced production schedule in order to balance the rolling mill and the finishing end.

There is a very large stocking area between the cut-off machines and the finishing floor. The finishing floor in the No. 4 building is designed to take about 40 per cent of the product of the mill. The balance of the product is finished on other existing floors in the buttweld and seamless mill areas.

G. E. Brock: In the new continuous rolling or mandrel mill, the question arises as to whether much difficulty has been experienced in maintaining perfectly straight mandrel bars and what steps have been taken for means of quickly removing crooked bars, to eliminate any interruption of the continuous operations?

John L. Young: Right now we are having very little trouble in keeping the bars straight, but in the early days of starting up this mill, we had difficulty in keeping them straight and for a time we could not make mandrels fast enough to keep up with the mill production. However, we finally found a very interesting discrepancy. Someone had made a change on the drawing for the roll setting gauge which threw each mill stand ¼ in. out of line, with the result that the mandrel and the hollow were going through like a snake. When this error was corrected, the bars stayed straight and have been straight ever since.

P. E. Flautz: Unquestionably this Lorain mill has potential output capacity for small diameter pipe and tubing far beyond any seamless tube mill ever built — continuous or otherwise.

The quoted figures of 40 tons per hour output or 3 tubes per minute, will no doubt eventually appear conservative. Certainly the continuous mill rolling speeds will permit greater production, as will the fast reducing mill speeds. The billet furnace is rated as capable of heating up to 75 tons per hour. Piercing rate would then seem to be the factor which will ultimately limit output, but perhaps only to a narrow extent. The industry in general is now frequently exceeding 3 tubes per minute production — for 25-ft long pierced billets over extended periods of operation. This new modern high speed piercing mill with a comparatively short outlet section should exceed all present producing rates.

The elongations obtained with the Lorain rolling on a bar unit, make a review of some past practices interesting.

In addition to those mills mentioned by Mr. Young, in his paper, Pittsburgh Steel Products Co., at Monessen, Pa., operated two continuous, rolling-on-a-bar units from 1913 until 1924. These were 7-stand horizontal-vertical miles and were alternately fed the product of one mannesman piercing mill. The maximum pierced billet length obtainable was 8 ft, and 3¼-in. diameter solids were the largest rounds used. One 7-stand mill was located at the right of the piercer outlet, the other to the left. The two sets of roll stands were driven by a common flywheel with one main 500 hp, a-c, motor and rope drive. Each mill had the same fixed gear speed ratios per pass which permitted last stand rolling speeds in excess of 650 fpm for 16-in. maximum roll diameters. The maximum tube size rolled was 2⅝ in. outside diameter and 1⅜ in. outside diameter was the minimum. Mostly, the rolled wall was 0.165 in. average. Rolling mill mandrel bar length approximated 30 feet, and the maximum rolled tube length seldom exceeded 25 feet. A chain extractor at each rolling mill location was used for mandrel bar removal from the rolled tubular billet. After rolling, no further hot working was performed. The product from the continuous mill went directly to reeler type cold draw benches and was marketed therefrom in the early days, mostly as bicycle tubing and boiler tubing.

With these mills, production rates of 200 pieces per hour were not uncommon. The difficult job was to keep them running efficiently due to light construction features along with poor equipment strength and design commensurate with the era.

That the tubing directly from these mills was not round or of uniform wall thickness, did not matter. Subsequent cold drawing corrected such deficiencies and the finished product was of excellent quality.

In 1919 two more so-called continuous mills were placed in operation at Pittsburgh Steel Company's plant at Allenport, Pa. They were of similar design and arrangement to the Monessen mills, but were operated only for an approximate two year period. It is interesting to note from past records that the Allenport mills rolled approximately 500 tubes on the very first turn of operation. That was a real achievement.

With these light, poorly constructed, 7-stand mills — rolling elongations were mostly 200 per cent in excess of pierced billet lengths. This merely indicates that the full rolling possibilities of this modern rigid 9-stand mill have not as yet been explored.

The total billet area reductions which can be effected efficiently by this new mill may prove to be greatly in excess of that now obtained. Certainly mill capacity in this respect is not limited to the present. There would seem to be vast possibilities for future development and rolling practice alteration. For this, National Tube Co. is to be congratulated. Such a condition has not existed too many times — with new installations in the seamless industry.

From steel yard to shipping bay this new mill assembly with its continuous flow lines and standardized steel size undoubtedly offers low cost production possibilities. The advanced engineering principles as applied, the small amount of direct labor for high tonnage output, indicate that this mill should produce small diameter seamless tubing at a lower cost than ever before attained anywhere in the industry.

Although Mr. Young makes no mention of finished tubing quality, it is assumed from general reports that the product standard is high. Yet, even with rolled tube lengths in excess of 100 feet where the 14½-in. roll center — tension reducing mill is employed, crop end loss per tube must be an item of considerable magnitude. This resulting heavy tube end section naturally affects yield adversely.

Were it not for the relative yield situation, it is not difficult to conceive of an ultimate finished tubing cost comparable with the product from continuous welded mills. If that yield differential between the two processes ever becomes negligible, then there seems little doubt of more seamless tubing, re-entering the highly competitive welded pipe and tube markets. Perhaps total operating efficiencies of this new mill will overcome any yield differential.

It must be admitted, however, that welded pipe mills remain more continuous than the most continuous seamless mill. The problem for the future is — how to make a continuous seamless tube mill more continuous. National Tube Co. has certainly taken more than the first step. The creation of this new expensive mill expresses their faith in the future of small size seamless tubing. Competitively the process must be viewed with great respect.

A. B. Capron: Those of us in the "department store" branch of the seamless tube industry are envious of a mill that can be designed for one billet diameter, produce one size of pierced hollow, and run for days on one product.

We are very much interested in the piercer installation at Lorain. For years, our company has been using a cone-type mill while others have used the regular mannesman mill as described by Ross McLaren in an AISE paper some years ago.

This new piercer at Lorain is a cone-type mill in one sense; the roll shafts are at an angle with the pass line in the horizontal plane, and its rolls are truncated cones with bearings on both ends, instead of overhung cones as we have. It also operates in the opposite direction from ours — the billets are gripped by the cones at their big diameter, and the pierced hollow leaves the cones at a point where their diameter is small. On our mills, the exact opposite is found, the billet enters the pass at the small end of the cones and leaves the cones at the large end. Our pierced hollow is about ⅜ in. larger than our billet size, whereas, I understand that at Lorain, the pierced hollow is the same outside diameter as the billet or slightly smaller. I would like to know what the Lorain experience has been on seam rejection with this type of piercer as compared to the normal mannesman type. On the matter of tools, I wonder, also, what effect the small pierced hollow diameter has had on the life of piercer points and shoes.

Running one size of steel all the time would make it easy to build up a good record on tool life, and the results will probably make those of us who have to change steel size every five minutes, very envious of the results.

On our elongator or a continuous rolling mill, the lubrication of the mandrel bar is usually a messy or smoky business, and many schemes have been tried out by all of us. At Lorain the problem is magnified by the size and length of the bars, and I would like to know what your solution has been. The life of the bar surface depends greatly on this lubrication and the toolage cost would be in proportion to this surface life.

John L. Young: The lubrication of the mandrel bar is another headache. I think we have tried everything, but at the present moment we are back where we started with black oil. We have found many lubricants that eliminate the smoke and do a beautiful lubricating job, but the cost per ton is prohibitive. By properly metering the oil and with close control, we have been gradually cutting down the smoke to a point where it is now not too objectionable.

Bryant Bannister: On the matter of points, we get sufficiently high speeds out of the piercer, which means that the points are subjected to heating for a minimum of time and, while I do not have the figures to substantiate this statement, I believe the life of the points on this mill is better, and the thrust bar rotation quieter than on our standard mills.

We have planned putting water-cooled points on this mill, doing away with the plugger.

R. E. Dewey: The production capacity and efficiency of the Lorain mill for making pipe sizes in large quantities is without question; however, the quality of the product is equally important. I believe the discussion of quality has been somewhat confined to the piercing operation, where it was said to be excellent.

Since we judge such things by comparison I wonder if Mr. Young would give us a comparison of the quality of the tube made on the mandrel mill as against the conventional plug mill, with particular reference to wall tolerance, and eccentricity. To what extent does the mandrel mill minimize eccentricity?

John L. Young: I think the simplest way to answer is — you all know you have a tolerance of plus or minus ten per cent of the wall. We are within five. In other words, within half or a little less of the tolerance.

Selecting Gears

FOR ROLLING MILL EQUIPMENT

By E. C. DENNE

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. . . . gearing is an art as well as a science . . . . satisfactory results can come only by combining experience with sound engineering judgment . . . .

▲ LITTLE has been written on the selection and application of gears for rolling mill equipment. Since the problem is so comprehensive it is impossible to more than touch on the subject in a single paper, for it must be realized that many factors enter into the proper selection and application of gears.

Looking at the subject of gearing from the standpoint of the uninitiated, it is easy to visualize his confusion or frustration when confronted with a gear problem. Generally, the first instinct is to determine the type and size of gears needed from the standpoint of strength. He does not have the detailed appraisal knowledge of the art in its many ramifications to guide or assure him in his selection. He is not familiar with the evolution of gearing and the influence of old practices on present day facilities and designs.

The procedure of resorting to old drawings plays a major role in guiding him in his selection of pitch, tooth form, material, etc. Very often spare gears are ordered for old equipment, which should be changed to suit modern cutting practices. Unnecessary special teeth penalize the customer in price, extra tool charges, and long deliveries. Much of the special tooth design is handed down from the cast tooth era, which accounts for the substituted "Off Brand" cut tooth gears in old rolling mill equipment today.

Gearing is an art and not an exact science. It is based on experience covering many variables, all of which have their influence upon the final gear selection. In reviewing some of the following variables, it can readily be seen that each can exert its effect upon the ultimate selection of the gears.

1. Space limitations.
2. Ratio.
3. Velocity.
4. Load.
5. Type of service.
6. Face and pitch diameter relation.
7. Material and hardness.
8. Tooth pressure angle.
9. Tooth proportions.
10. Helix angle.
11. Foundation.
12. Quality of workmanship.
13. Rigidity of system.
14. Type of bearing mountings.
15. Lubrication.
16. Weather conditions.
17. Ambient temperatures.
18. Operating practices.
19. Preventive maintenance practice.
20. Reciprocity.
21. Price and competition.
22. Noise level requirements.
23. Life expectancy.
24. Accessibility.
25. Chatterless operation.

It is not too difficult to imagine the effect which some of the variables may have on the selection of a gear set, yet many users fail to recognize them. Quite frequently users of gears order to a pet material specification, or no specification at all, and are at a loss to understand why their gears are not functioning properly.

This same procedure is also practiced by some of the equipment builders. The layout of the equipment is made with very little thought given to the gears or their lubrication, forgetting that the useful life of the equipment depends on the proper functioning of its driving gears. As a rule the above does not apply to individual mill drives and standard reducers, since they are self contained and incorporate factors for the variables in their design and generally use AGMA practice as a common denominator.

The main purpose of this paper is to bring out some of the conditions that influence the selection and application of gear sets built integral into the equipment or special drives, and does not cover main mill drives, and standard reducers.

Before a type or design of gear can be specified for any particular application, an overall view of the complete assembly is necessary. It is not sufficient to assume, that since good results were obtained from the usage of a certain type of gear in another wholly different application, it is adequate for the proposed installation. There are the following common types of gears, none of which has a universal application:

1. Spurs.
2. Single helical.

3. Double helical — herringbone.
4. Spiral.
5. Straight tooth bevel.
6. Spiral bevel.
7. Conventional worms.
8. Cone worms (double enveloping type).
9. Staggered spurs.
10. Staggered double helical.

The teeth may be of any one of the three standard pressure angles — 14½ degree, 20 degree full depth, and 20 degree stub. As a matter of fact, even higher pressure angles are oftentimes used to advantage.

A brief elementary explanation of the systems is as follows. The pressure angle of 14½ degrees was selected back in the cast tooth era. Its natural sine is ¼ and is a convenient fraction for the gear engineer and pattern maker when laying out the teeth. The tooth profile is modified for the purpose of eliminating undercutting. Undercut teeth are undesirable. This is eliminated through the use of the 14½ degree composite system and employs a series of form milling cutters for the manufacture of such teeth. This is purely a milling operation and the form of the teeth is automatically fixed by the shape of the cutter. It is not a generating process. Therefore long and short addenda teeth, increased centers, and other pressure angles cannot be produced by the same cutter. It would mean a new cutter for each condition. Do not confuse this type of cutting with generated cutting methods. When generating teeth, long and short addenda, increased centers and higher pressure angles can be produced with standard generator cutters.

The standard 14½ degree involute system unlike the composite 14½ degree has a full involute tooth profile for gears having more than 32 teeth. The application of long and short addenda or increased centers is a means of improving the profile and of eliminating undercutting of teeth. In other words, the less sensitive part of the involute curve is used when generating the teeth, and can be generated with standard cutting tools.

Gears manufactured by the above two systems are not interchangeable. The standard 20 degree involute system is the same as the standard 14½ degree involute system except for pressure angle. Eighteen teeth and under are undercut. The same refinements of long and short addenda and increased centers can be employed as in the standard 14½ degree involute system to eliminate undercutting.

The 20 degree involute stub system is the same as the standard 20 degree involute system except the teeth are shorter. The same refinements can be favorably employed as for the other systems. Fourteen teeth and under will be undercut unless the above refinements are incorporated in the design.

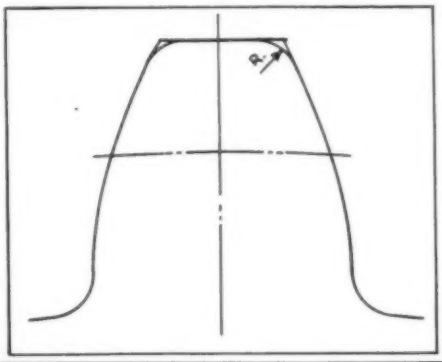
None of the above involute systems are interchangeable.

For general rolling mill work (excepting standard reducers) the writer prefers the general usage of the 20 degree involute stub system especially for helical and herringbone gears. (There are exceptional cases, of course.) In most instances it is refined by the application of long and short addendum, increased centers or higher pressure angles. The increase in bearing load due to higher pressure angles is small and practically negligible. It amounts to approximately ¾ of 1 per cent per degree rise, and only 11.1 per cent from 14½ to 30 degree pressure angle. These refinements do not always require special tools. Of course each supplier is limited to the facilities available.

There are many tricks that the gear designer can employ with standard tooling to increase the useful performance of a gear set. Regardless of the type of gear and tooth form incorporated into the design, nothing will replace machining and assembly accuracies for better gear performance. Many questionably designed gears have operated satisfactorily because of accurate machining.

The following examples of a few typical gear installations will better illustrate some of the factors influencing the proper selection and application of same.

Figure 1 — If tip relief radii are provided for form cut teeth as indicated here, wear life will be increased.



DP	CP	R
⅓	9.4	¾
⅜	8.378	¾
½	6.283	½
⅝	5.027	⅜
¾	4.189	⅜
⅞	3.590	¼
1	3.142	¼
1¼	2.513	¼
1½	2.094	⅛
1¾	1.795	⅛

DRIVES FOR ENTRY AND DELIVERY FEED ROLLERS FOR BLOOMING AND SLABBING MILLS

These drives encounter high impact loads. Those unaware of the severe service may err in designing the gears and connecting couplings on the basis of the nominal motor horsepower and speed. If so, trouble is soon to follow. Some of the factors which must be considered are as follows:

a. High impact loads — slab or ingot banging down on rollers when going through the mill.
b. Feed rollers operating on loose bronzes add an additional problem of alignment.
c. Space limitations.
d. Quick reversing service.

On the basis of the above conditions, it is necessary

to design the gears both for durability and strength horsepower with a reasonable service factor. The motors are capable of delivering high momentary torques of about 450 per cent nominal. In addition the impact, from pounding of slab or ingot, produces high dynamic loads. It is also desirable to have a coupling capable of taking extreme misalignment. If gear tooth coupling is used, the extended type is a necessity. Because of space limitations, the drive is usually a combination of vertical and horizontal gear centers.

Normally a double helical 20 degree or higher pressure angle involute stub tooth is specified with pinions made of alloy forged steel, heat treated to a hardness consistent with accurate cutting. The gears are of plain 0.40 to 0.50 per cent carbon cast steel annealed, or alloy cast steel heat treated to a hardness also consistent with accurate cutting. The gears must be properly mounted in either anti-friction or sleeve type bearings, in rigid mounting, and lubricated with an extreme pressure lubricant having a viscosity consistent with the load, tooth pitch and velocity, either splash or connected to a central lubrication system.

FRONT AND BACK TABLE BEVELS FOR BLOOMING AND SLABBING MILLS

Here again is the same type of severe service, with:

a. Quick reversing.
b. High impact loads from banging of slabs and ingots on table when slab or ingot leaves the mill.
c. Scale and dirt.
d. Misalignment.
e. Fast acceleration.
f. Space limitations.
g. Heat.

The size of slab or ingot to be conveyed by the table automatically determines spacing and size of table rollers and bevels. A straight tooth bevel is the only practical type of gear that can satisfactorily be used direct in this application. The centers of rollers are too close to permit the assembly of both flexible couplings and bearings between each bevel set. Therefore, spiral bevels are not applicable because individual alignment cannot be made. Spiral gears are not practical, having point contact only. Spurs and helicals are not adaptable.

Therefore, generated straight tooth bevels with a slight tooth crown, having a tough core and a hard wearing surface is the ideal approach. Experience has shown that an alloy steel gear, heat treated before machining within the limits of machinability, is desirable from a breakage standpoint, but does not satisfy wear conditions. Under severe service the wear life is only a few months.

Alloy carburized bevels have given a very good account of themselves under extreme service, since they have both a tough core and a hard wearing surface. However, care must be exercised in their use, because there is a certain amount of distortion present which may cause toe or heel bearing and produce tooth breakage without warning. This can be overcome when assembling gears by grinding the teeth to secure contact in a zone between toe and heel. It must be remembered that a line shaft assembly may have about 15 sets of bevels. A few thousandths error in line shaft alignment will also contribute to toe or heel tooth bearing.

A slight crown or curvature of the tooth produced when generating the teeth is advantageous. This permits the load zone to come within the toe and heel and allows for approximately 0.005 inches misalignment of line shaft. This is assuming that gears are not unduly distorted. On the basis of the above, the following is also a very desirable specification:

SAE 4340 forged steel, heat treated to 200-240 brinell, finished machined, (except bore) and cut. The machined cut blanks are then hardened to 450-500 brinell by radiant heat method and quenched in oil. The gears are drawn back to a hardness of 350/400 brinell and bore finish machined.

The above specification more nearly satisfies the necessary requirements from every standpoint, namely tough core, hard wearing surface, minimum distortion. The crown generated on teeth eliminates the costly hand fitting and grinding of teeth for zone contact, and this is important when customer installs spares. The above specification is used on new bloomer tables in operation more than a year with no known failures to date.

PINION STANDS

There are many types of pinion stands, from the old cast tooth gear shield lubricated open housing type, to the up-to-date totally enclosed cut tooth helical type pinions mounted in sleeve or roller bearings. The function of all types is of course precisely the same. Many of the old type have cycloidal pinion teeth. Except for spares, this tooth form is practically discontinued, since the involute form satisfies most requirements in the rolling mill field.

There are some staggered spurs which in the absence of double helical serve their purpose. They give more tooth overlap in plane of rotation and are smoother operating than the straight spur teeth. There is in general no need of this construction in present day design.

The physical dimensions of mill pinions are usually fixed by roll diameter, spindle length and angularity, load and speed. The face dimension of pinion must be kept within reason. A long slender pinion will not necessarily carry more load than a stubbier type, both having the same pitch diameter. Very often the designer forgets that excessive deflections will cause failure of the pinions since the load will not be uniformly distributed, but will be localized. In general a good proportion for face is 1½ times pitch diameter; in many cases this is increased to 2½ and higher. Each problem must be investigated.

It must not be forgotten that a certain amount of deflection is always present where the load is supported between bearings. One must keep within practical deflection limits. A pair of pinions can be accurately cut, mounted in an accurate housing, lapped and show full face contact; yet in the field under load, partial contact may only exist. A certain amount of "wear in" is necessary to overcome concentrations due to deflection and other minute inaccuracies.

Many gear users fail to realize that even the present day automobile gears are "run in" for a few hundred

miles at reasonable speed before operating at maximum speeds. These auto gears are precision made and are thoroughly checked and tested, yet mill men expect to jump into high speed production upon installation of rolling mill equipment and it is surprising how well they get away with it.

The type of spindle influences the design of pinion teeth. If of the wobbler type and the wobbler becomes worn to a taper, it can exert a high thrust depending on the magnitude of its wear. Normally speaking, a single helical set of pinions would be the answer. However, there are many satisfactory installations incorporating the use of double helical pinions. Either design may be used. Single helical pinions can be satisfactorily mounted in either sleeve or anti-friction bearings with one bearing on each pinion held and the others free to float.

Double helicals also can be mounted either in sleeve or anti-friction bearings. If sleeve mounted, all pinions are provided with a thrust bearing — having a slight lateral clearance so that they do not jam endwise. This does not appear to be good design. Nevertheless there are many such installations working very satisfactorily. If pinions are mounted in roller bearings, one bearing is stabilized and all the others are free to float.

When universal spindles are specified, no appreciable thrust can be present, and any one of the above combinations can be satisfactorily used.

There are many variable factors which influence the choice and selection of the details entering into a well rounded mill pinion design. For example, a blooming mill pinion is called upon to take high impact and reversing loads. The designer must first consider the physical dimensions which may or may not be limited by available cutting facilities. After pitch diameter and face are established, a selection of pitch and helix angle is determined. A blooming mill pinion is a relatively large piece, and requires heavy cutting equipment to generate or cut the teeth. It is harder to control the heat treating, machining accuracies, etc. of large blanks than of small ones. The loads vary and contacts change because of changing deflections. Therefore until pinions wear in for maximum load conditions, full face contact may not be present. This means a concentration of load higher than the average. Too light a pitched tooth may not be adequate from breakage standpoint, and too coarse a pitch may result in small numbers of teeth not conducive to good wear.

There is no object in having a single or double helical gear instead of a spur unless it serves a purpose. There should be a helical overlap of teeth, the amount depending on conditions, such as speed, thrust, etc. By overlap it is meant that a tooth or more is coming into contact before the loaded tooth or teeth leave the load zone. This will under normal conditions produce smooth operation, which otherwise may not be obtained.

There has been much written about tooth deflections, and the resultant damages caused to tooth surfaces. Since it is impossible to cut or generate teeth of large gears and pinions to allow for exact deflection curves under varying loads, a compromise tip relief is incorporated into the tooth form. This relief is designed into the large generator cutters for 2 diametrical pitch and coarser in the form of an involute which gradually flows into the regular involute profile. The involute recedes more at the tip of the tooth than the regular relief incorporated in standard cutters. This permits the gears to engage without any tip interference, and as normal wear takes place in the life of the gear teeth, the contact ratio increases. Figure 1 shows illustration and tabulation of tip radii for the different diametral pitches incorporated in the form cutters for the large pitches for gears operating at relatively slow speeds. The curve was merely selected as a radius for expediency sake; any other curve which would gracefully blend into the tooth involute profile and provide a tip relief would be satisfactory. This particular curve happened to agree with the production facilities.

This relief is of a different nature than the normal relief applied to standard generating tools. There are many who argue against it. Excellent results have been obtained with its usage in the past eight years. The surface of the teeth, when under load in heavily loaded mill pinions and gears, is damaged by the tip of the tooth of the driven member when coming into mesh with the driver, when same are cut with standard profile cutters. On all extra heavy pitches, a large relief should be incorporated at the tip of the teeth. This overcomes the gouging effect produced by tip interference. The reasoning is based on the following premise: in generating large gear teeth with standard cutters, the tip of cutter is sensitive and produces a thicker tooth at the lower portion. When the tip of the mating tooth comes into contact, there is an interference and surface damage follows. This surface failure cuts down the contact ratio or number of teeth in contact. The contact ratio is about the same in both cases, if anything it is more favorable for the tip relieved tooth. In addition the tip relief provides a wedge for good lubrication, whereas the "untip relief tooth" scrapes the heavy lubricant from its meshing mate causing surface failure.

Tip fins, burrs, etc. caused by tip interference or otherwise is not conducive to long life of gears, and it is good preventive maintenance to carefully remove such lubricant removers as soon as noted with a pencil grinder or file. Care must be exercised to not provide too much tip relief on spurs.

Much can be written about mill pinions with respect to material specifications, hardness, special high pressure angles, lubrication, backlash, and many other factors all of which a good design takes into consideration.

SCREWDOWN WORM GEAR SETS

In practically every plant, there is a troublesome gear causing mill down time and eternal maintenance. In many cases the original design was adequate for the immediate needs. Speedups in production and other changing conditions may have increased the burden on these gears so that they are now being loaded to the limit. Changes in materials, hardness and type of gear "may" be the answer. As an example, one manufacturer was replacing screwdown conventional worms and wheels every week to ten days. See Figure 2. This represents a costly down time and maintenance expense. The original design was adequate and operated satisfactorily for years, until changes in production upset the balance. Then trouble began and the gears would

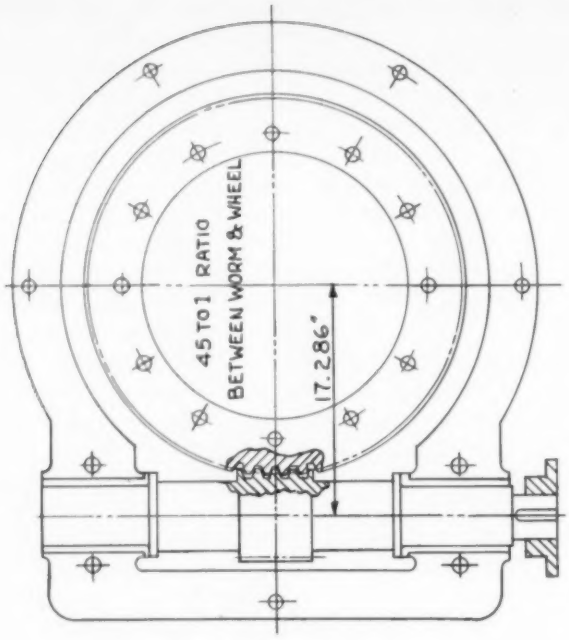


Figure 2 — The straight worm assembly, on the screwdown shown, operated satisfactorily on the original design, but was not satisfactory when production was changed.

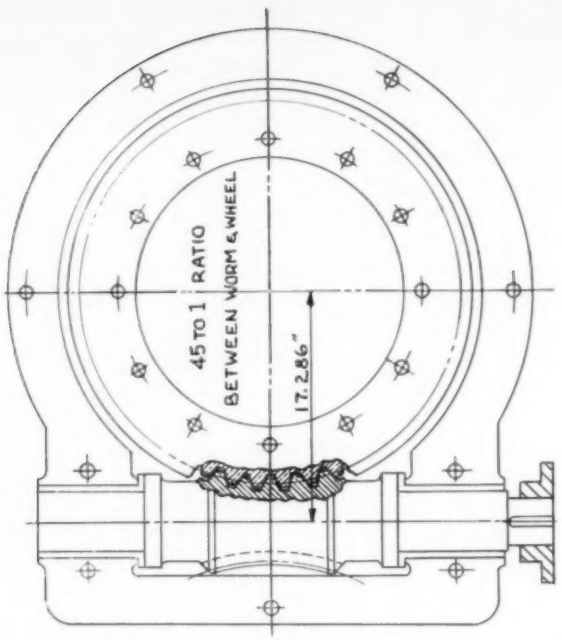


Figure 3 — When double enveloping worm gears were mounted on the old screwdown, satisfactory service was achieved.

not take the additional duty. Change in materials and hardness did not remedy the situation and was not the solution. A design change incorporating the use of double enveloping worm gears assembled in the same centers, bearings, and housing solved the problem (see Figure 3). These gears are of the double enveloping type and ideally fitted for the above screwdown service. They have great load carrying capacity for the slow speed screwdown service, as can be seen by referring to curve at Figure 4. Note that a 24-in. center distance gear set has an output torque rating of 3,200,000 in. lb, for screwdown service of 100 rpm of worm or less. Of course for other types of application or higher speeds and continuous operation, their torque rating is less. There are many cases where the double enveloping gear sets, lubricated by extreme pressure lubricant, has solved the problem.

INGOT CARS

Another example of severe shock service is the driving of heavy duty ingot cars. Space is limited by wheel size and track clearance presents a tough drive problem. Drive ratio is usually about 5 to 15/1. High braking loads, rough and scaled tracks, quick stopping and reversing conditions impose terrific loads on the small gears. Unless a suitable set of gears is built into the ingot car, costly maintenance can be expected. Experience shows that the double enveloping drive tops the list of gearing for this type of installation. It is compact, has high torque rating, low WR^2, many teeth in contact, large surface contact of teeth in load zone, good efficiency in the above ratio range, and is smooth operating. The worm gear is mounted on the axle and contained in housing with the worm, flexible-coupled to the motor, all mounted on integral, spring adjusted bed plate. Since the worm is above, a small lubricating pump is provided for lubricating gears and bearings with extreme pressure lead naphthenate, non-corrosive, non-etching lubricant. (The ratings shown on Figure 4 are not applicable to this service. The service for ingot cars is of a more continuous nature, and of higher speed.)

TIMING GEARS

Occasionally it is necessary to replace a set of special gears that have been satisfactorily operating for 30 to 40 years. An inquiry for such a set was considered and after reviewing the drawing it was turned down for lack of suitable cutter. They were large spiral valve timing gears on a blowing engine. This type of gear is sensitive to design and installation accuracies and will either wear for years or for a few days. The customer was in trouble and requested that an available 20 degree pressure angle cutter be substituted in order to expedite delivery. These did not work. A harder material was used and that did not work. Finally a new cutter of 14½ degree pressure angle was used to generate the teeth on a low tensile soft cast iron blank. The gears were lapped in the shop and further conditioned in place to insure proper contact. The back lash side of teeth were also buffed in place. This was necessary for this installation, otherwise the gears would not last a week. The gears of 14½ degree pressure angle soft cast iron blank operated approximately two years before failure.

The AGMA Standards and standard practices can be applied to practically all rolling mill gearing and drives, if the designer applies proper service factors and refinements when considering the variables.

SOME HELPFUL SUGGESTIONS

1. Do not replace spur gears with double helicals in an existing installation where all the bearings

are held or positioned endwise. The chances are against the proper positioning of gears for full face contact unless all bearings but one are free to float.

2. If spur gear set in an existing installation is noisy, same can generally be replaced by a single or double helical set of sufficient helix overlap. Be sure to check bearings for thrust and radial load imposed. If double helical, follow the suggestion above, it is understood that helix overlap is also essential in double helical gears.
3. Spiral bevels should be assembled in adjustable cartridges or provision made for other suitable means of obtaining proper tooth contact.
4. When ordering spiral bevels, always order them in pairs. They are cut as a pair. An existing worn spiral bevel will not operate to best advantage with a new one.
5. Do not replace existing cast tooth pinions in an old open type pinion stand with cut tooth pinions and expect your troubles to cease without checking into the situation. Make sure the housing is rigid, well anchored to good foundation, bearings aligned and maintained and suitably lubricated.
6. Dip or splash lubrication where thermal requirements are met is probably the simplest and most satisfactory method. Of course there are limits to its use. For example, heavily loaded, 3-high mill pinions with the bottom pinion dipping in a heavy viscous lubricant may be very inadequately lubricated. Even under normal operating conditions, a copious supply of lubricant cannot be expected for lubricating the mesh of middle and top pinion. In case of "over-the-week-end" shutdown, the lubricant becomes very viscous in lower temperatures, and the teeth are apt to channel through lubricant when starting up. This is not conducive to good pinion life.
7. Periodically check and test lubricant for main mill drives and gear sets. Keep the lubricant within the specification recommended by the supplier of the drive. Poor lubrication has been the cause of many gear failures.
8. Preventive maintenance pays large dividends. Tighten all cap bolts if loose, remove all sharp corners, fins and burrs on gear teeth when formed. A little attention of this kind will save costly shutdowns. A few dressings may only be necessary to obtain much increased life from your gears.
9. In many sets of mill pinions the teeth can be improved both from the standpoint of breakage and wear. See Figure 5. For example a 24-tooth pinion, ¾ diametrical pitch, 32-in. pitch diameter, 20 degree pressure angle can be changed to 22 teeth and generated with the same cutter. The outside diameter does not change, yet the tooth is materially improved by simply using the less sensitive portion of the involute curve.
10. Theoretically we can expect new gears to behave as anticipated only on the drawing board. It is a rare occasion to obtain full face bearing across their faces when assembled in their housing. In most cases, the bearing is concentrated at one or the other end of the teeth. Such being the case, it is unreasonable to expect good tooth bearing with a new pinion and an old gear assembly or vice versa.
11. When ordering new gears to replace troublesome ones, state the conditions of their operations in detail, and submit arrangement and detail drawing to supplier. Supplier is then in a good position to diagnose the trouble and recommend a cure. Otherwise you will only be buying a pair of gears, which may or may not give satisfactory performance.
12. The minimum number of teeth to eliminate undercut in a gear or pinion of unmodified involute profile tooth form for standard 14½ degree, standard 20 degree full depth, and 20 degree stub pressure angle is 32, 18 and 14 teeth respectively. Long and short addenda, increased centers, and other tooth modifications should be used for low

Figure 4 — Graph gives torque rating for a 50 to 1 ratio cone worm set for low speed screwdown service.

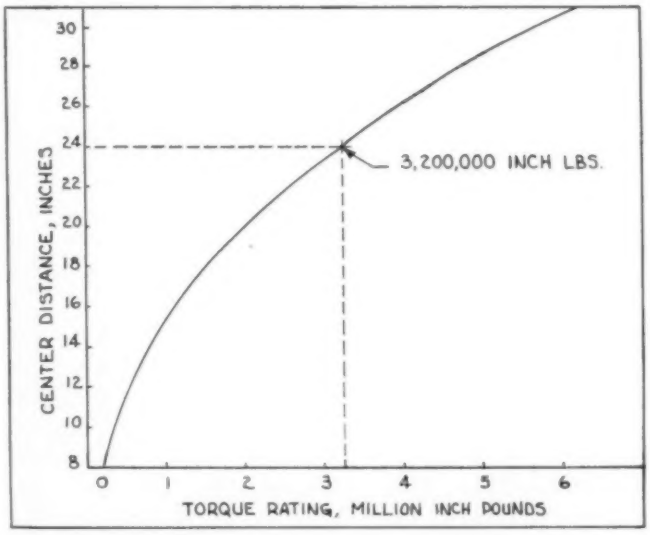
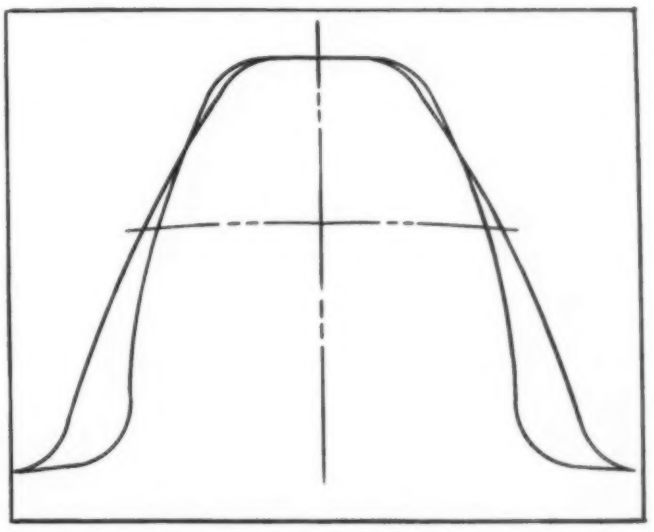


Figure 5 — Sketch shows profile of a 24 tooth, ¾ diametral pitch, 32-in. pitch diameter, 20 degree involute pinion generated with only 22 teeth. This technique reduces undercut and gives some tip relief.



numbers of teeth to eliminate undercutting.

13. A separate universal coupling mounted on pinion neck is preferable to an integral coupling and pinion. The first cost is more but long term cost is generally much less. Of course, space limitations will dictate the final choice.
14. Back lash. All gears require back lash including gears specified without backlash. Tight gears will not operate satisfactorily, and except for specific instances, it is better to have ample back lash than have too little.
15. There are many gear suppliers available to furnish your requirements. Keep in mind that each supplier's facilities are best suited for producing certain types and sizes of gears. Many suppliers are set up to produce gears in the average and largest sizes only, who are not equipped to produce smaller gears competitively, and do not have the experience and technique of those in the smaller size field. And by the same token, the reverse is true of the small gear producers. Materials, hardness, heat treatments, cutting practices, etc. that can be suitably applied to smaller gears, may be totally impractical and unsuitable for large gears.

SUMMARY

The main purpose of this paper is to bring out the importance of the factors that influence the selection of the type of gear set for each application. No type of gear set, material specifications, hardness specifications, etc. has universal application. The proper gear set is one that economically satisfies the variable conditions under which it must satisfactorily operate. After the conditions are evaluated, selection of gear details can be determined.

DISCUSSION

PRESENTED BY

W. J. PEARSON, Machine Tool Engineer, Bethlehem Steel Co., Bethlehem, Pa.

F. RICHARDZ, Manager, Gearing Engineering, Westinghouse Electric Corp., Pittsburgh, Pa.

E. C. DENNE, Consultant and Manager of Gear Department, United Engineering and Foundry Co., Pittsburgh, Pa.

W. J. Pearson: In addition to the two dozen or so variables affecting gear selection that have been presented by Mr. Denne, I would like to add one more; that is, the necessity for machinery builders to supply adequate information on the individual components (in this case gears) so that in turn said information may be passed on to a gear supplier.

I would like to emphasize the statement made regarding the non-interchangeability of fourteen and one-half degree composite tooth form with fourteen and one-half full depth involute form. In supplying spares for certain types of equipment, there are many instances where the two types of tooth form are run together generally without knowledge on any one's part that such is the case. Only with plenty of backlash does the gear set operate and then at the expense of rapid wear and reduced efficiency.

In the paper it is mentioned that for general use, the twenty degree stub tooth form is preferred. I would like to ask why? In the maintenance of steel mill equipment, all types of gears are encountered though the majority are straight spur gears of 14½ degree composite, 14½ degree full depth involute or 20 degree full depth involute. With cutters available to supply repair parts of these tooth forms, it is felt that to add others is superfluous as with standard hobs and the possibilities of strengthening pinions by using long and short addendum forms or by cutting the pinion with one less tooth, the equivalent strength of the stub tooth may be obtained. It is in view of this requirement to maintain simplicity that the foregoing question is asked.

Except for the maintenance of spares, can Mr. Denne give any good reason for using cycloidal tooth forms? Any reason based on precedent is excepted in the question.

Has the author encountered any particular advantages in the use of the type tip relief as shown in the chart over an involute relief on large or coarse pitches, say 1½ diametral pitch or heavier? Is the type of relief in the chart applicable to spur gears?

I would like to ask Mr. Denne what his experience has been regarding difficulties in maintenance or replacement of enveloping type worm gears which work very nicely on initial installations, but have given some headaches when worked on during periodic maintenance by the average field mechanic.

F. Richardz: At times the uninitiated may look upon gearing as a necessary evil and just a means of transmitting torque, without giving any thought to the ramification and the consideration necessary to accomplish a satisfactory gear selection.

Mr. Denne stresses the importance of giving the gear manufacturer a chance to serve the industry better by giving a choice in producing the most satisfactory and lowest priced gears as such a choice will often enable the gear manufacturer to use his up-to-date tools and equipment, instead of resorting to the use of antiquated tools, and tools that may have to be resurrected from the antique department.

Mr. Denne refers to gearing as an "art." This in a good many respects, is true, and the surprising part is that it is one of the oldest arts and history indicates that gearing was to a certain extent known as early as 150 B.C., and yet, in many respects, gearing is in its infancy, as most of the progress made in the gearing field has been made in the last twenty-five to thirty years.

The gear manufacturers, particularly the gear manufacturers connected with AGMA where pooling of experiences and practices has resulted in the combined experiences invaluable to gear users, should be relied upon for suitable recommendations as to design, material and heat treatment of the gearing.

The gearing, as indicated by Mr. Denne's paper, is

primarily intended to cover gear drives built integrally into the equipment or special drivers. This is an important consideration, particularly since this phase of gearing is not as well known and understood as main mill drives and standard gear reducers and is more specialized, and consequently, requires expert interpretations for the various applications. The fifteen helpful suggestions outlined by Mr. Denne should prove to be helpful, not only to gear manufacturers, but to the users as well and, in my estimation, it will be well to review these points from time to time as they are pertinent and to the point.

E. C. Denne: There are many gear details through out the industry with insufficient information to produce the gears. In many cases, the pressure angle is not specified. Generally speaking, this is especially true of old crane gear details. No doubt the 14½ degree was the only pressure angle used and therefore, it was assumed as common knowledge and did not appear on the detail.

Why does the writer prefer the 20 degree stub tooth form? It is true that a great majority of small miscellaneous gears have a 14½ degree pressure angle. This angle, as stated in my paper, originated largely because of its simplicity for the pattern maker and the draftsman in laying out the teeth. This practice of 14½ degree continued when form-cut and generated teeth came into use. Naturally, replacements of a mating gear or pinion would be produced having the same pressure angle. Obviously, we cannot overlook the fact that available facilities and precedent has much to do with continued use of the 14½ degree pressure angle in rolling mill equipment gears.

Most miscellaneous spur gears in rolling mill equipment operate at relatively slow speeds and high loads. The 20 degree stub tooth, in most cases, is preferable to the 14½ and 20 degree long tooth, in rolling mill equipment. It is stronger, and less sensitive to bearing misalignment and better adapted to low numbers of teeth. We cannot overlook the many variables when making our selection — such as equipment rigidity, speed, quality of maintenance of bearings and their alignment, lubrication, etc.

It is our practice to use single or double helical gears, generally 20 degree stub teeth wherever possible instead of spurs in modern rolling mill equipment.

Except for the replacement of spares, there is no good reason for using cycloidal tooth forms in rolling mill equipment gears, as far as I know.

The tip relief shown in Figure 1, as stated in the paper, is for heavy double helical (not spurs) "form-cut" teeth. There is no advantage of the radii tip relief shown in Figure 1 over an involute type. We use an involute type on all our larger pitch "generator" cutters instead of a radius. We use the radius only for "form-cut" teeth. The relief shown in Figure 1 is not adaptable to spur gears or pinions except in gears or pinions having larger numbers of teeth, because it affects its contact ratio too much. The amount of tip relief, therefore, for spur gears depends on the conditions under which the gear operates, the number of teeth, etc.

Our experience with double enveloping type worm gears (cone type only) during our 15 years of their usage has been excellent. We manufacture the housing bores and centers to the same machining tolerances as we would for the straight face conventional type. Each set is assembled in their cartridge adjusted housing and checked for contact in accordance with contact adjusting manual of instructions. Like any other set of gears, the more accurately they are machined and mounted, the more satisfactorily they will operate. This type of gear (both gear and worm) is regenerative, and has the faculty of wearing out to wear in. In other words, any slight inaccuracies in machining and assembling are self-corrective, provided the gear set has been properly rated. No gear set will operate satisfactorily if it is loaded beyond its maximum capacity. We have very little maintenance on the double enveloping worm gear sets in the field to date, after 15 years of usage. If properly rated, lubricated, and adjusted, maintenance is negligible. In unusual cases, pitting of the gear teeth may require some tooth surface manicuring.

Improper application may cause trouble. For example, two or more double enveloping gear sets driven by two continuous worm shafts, assembled in a locked circuit will not satisfactorily operate except by accident, even though fitted in the shop. This would also be true of any other type of gears in a locked system. Under load, the gears will not take their calculated division of load because of angular deflections and machining discrepancies.

I would like to point out that most of our reducer designs incorporate single helical gears driving the enveloping worm shaft to obtain the required speed ratio. This keeps down the number of cutters to a minimum. The difference between the cutter ratio and the reducer ratio is taken care of by the single helical gears. Each center distance and each ratio requires a separate cutter. Therefore, we have selected a certain number of cutters for each center distance having one or two ratios. Any other ratio required is obtained by the use of helical gear attachment.

We have in use large 28-in. center distance reducers without helical attachments having a speed ratio of 18⅓ to 1, with the worm driven directly by a 250-hp motor at 1200 rpm. The worm's average diameter is approximately 12 in. and it can be seen that the worm thread velocity is in the high speed range. The gear set is lubricated with an extreme pressure cooled lubricant and has now satisfactorily operated for three years.

There is one other problem that I want to bring out that no doubt many of you have encountered. Occasionally, you will be concerned over a set of gears or mill pinions whose tooth surface has become pitted or scored. The tooth surfaces should be manicured; that is, scraped, filed or pencil ground. All fins and burrs at the tooth tips should also be removed. Minute tooth surface machining inaccuracies, deflections, and mounting errors will change contact zone under load. This means that only a portion of the gear face is carrying the full load and this necessarily imposes higher unit loads. A certain amount of "corrective" failure is bound to take place and shows up in the form of pitting, etc. The loaded portion of the teeth can readily be ascertained by the surface appearance. Slight scraping by experienced mechanics can remove the high tooth surface and thus help to distribute the load over more of the face. Usually one such corrective measure is all that is necessary for their satisfactory operation. Very rarely is it necessary to recut the teeth.

SOME ASPECTS OF ANNEALING ATMOSPHERES FOR TIN PLATE STRIP

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. . . . annealing atmospheres may have a very important effect on the corrosion resistance and life of tin plate coatings. . . .

▲ DURING the past two decades the importance of controlled atmospheres for use in the annealing of steel for tin plate has grown to the place where today such use is not only a necessity in the present annealing process, but is also an important factor in determining the ultimate quality of the tin plate produced.

The introduction of cold reduced strip for tin plate, replacing the product of hot pack rolling, brought with it the opportunity for bright annealing. This was a real advancement in the appearance of the plate, decreased the pickling time and reduced the steel loss from pickling. For a period in the early years of cold reduced strip, some tin plate producers used raw fuel gas as a protective atmosphere. This left much to be desired.

The introduction of deox gas (DX) (the products of partial combustion of fuel gas) was a marked improvement over the use of raw fuel gases. Deox gas has been by far the most widely used protective atmosphere in the annealing of tin plate strip up to the present time. Today there are other protective atmospheres in use in the annealing of tin plate such as lean gas (NX) and nitrogen-hydrogen gas (NH). The use of these gases will be discussed in more detail later.

The growth of the use of controlled atmospheres for annealing tin plate paralleled the application of the cold reduced process to tin plate strip. This phenomenal increase may be expressed in many ways, but we would like to illustrate it by tonnage comparisons. In the past twenty years the tin plate tonnage has increased from a few thousand tons per year to a figure which approximates five million tons per year today. It might be of interest in passing to note that one or more of these gases are also used in the annealing of cold reduced strip and sheet steels, and these two products represent approximately three times the tonnage for tin plate.

One of the primary requirements in the production of quality tin plate is a clean surface. The annealing atmosphere maintains this clean surface and under some circumstances actually helps to clean a dirty surface. After cold reduction, the strip is put through a cleaning operation to remove rolling oils and any other contaminants that may be on the strip. The coils are then placed in the annealing furnace. The cleanliness and brightness of the surface of the strip is dependent to a large degree on the effectiveness of the protective atmosphere during the annealing cycle. The most common furnaces used in this country are the radiant type with inner cover or covers over the coils to hold the protective atmosphere surrounding the charge. It is common practice to seal these inner covers with sand. Before beginning the heating cycle, the atmosphere under the covers is purged for several hours with an oxygen-free gas, which in most cases is the same gas used during annealing. The temperature used for the annealing (either process annealing or box annealing) of these coils is usually in the range of 1170 to 1250 F. The length of the heating and soaking cycles will vary considerably with the total weight of the charge and the type furnace, but will usually be approximately 30 to 50 hours. Cooling usually takes much longer than the

heating requiring up to five days in some cases. The inner covers are not removed until the charge is sufficiently cool to prevent a deterioration of the charge. If a full bright strip is desired, the uncovering temperature should be approximately 250 F. The covers may be removed at a temperature of approximately 400 F if a blue oxide border is considered satisfactory. During this entire cycle, the protective atmosphere is maintained in the inner covers at a positive pressure of approximately 0.5 to 1.3 inches of water. A flow of gas of from approximately 400 to 1000 cfhr is required, depending on a large number of variables such as furnace size, tightness of sand seal, open or closed vent pipe, and temperature of the steel.

Some of the difficulties that may be encountered in the use of protective atmospheres are oxidized surface, carbon or soot deposit, and etched surface.

The oxidized strip may be traced to excess moisture in the gas, a leaking base or cover, insufficient gas pressure to prevent diffusion of oxygen into the inner cover or insufficient reducing agents in the gas to protect the steel in the presence of slight oxygen diffusion. This diffusion may be present in the use of any of the above mentioned gases. The carbon or soot deposit may result from insufficient cleaning or from a gas with a low moisture content. An etched surface may result from a gas with a low moisture content and a heavily unbalanced water gas equilibrium. These last two defects often occur under similar conditions, especially in those gases which support the water-gas reaction. If the moisture content is low, there is likely to be an unbalanced equilibrium, therefore, the carbon dioxide (CO_2) and hydrogen (H_2) combine to produce more water (H_2O) and carbon monoxide (CO). In these gases the steel surface is acting as a catalyst.

Table I shows the principal reactions that occur in the presence of tin plate steels and controlled atmospheres containing the gases shown. All of these reactions are reversible, depending upon the temperatures and the amounts of each reactant present.

TABLE I
Principal Reactions in the Presence of Tin Plate Steels and Controlled Atmospheres Containing Gases Shown

$CO + H_2O = CO_2 + H_2$	(1)
$C + CO_2 = 2CO$	(2)
$CH_4 = C + 2H_2$	(3)
$Fe + H_2O = FeO + H_2$	(4)
$Fe + CO_2 = FeO + CO$	(5)
$Fe_3C + CO_2 = 2CO + 3Fe$	(6)
$3Fe + CH_4 = Fe_3C + 2H_2$	(7)

It may be of interest to discuss briefly the composition and production of deox, lean and nitrogen-hydrogen gases.

Deox gas, as has been mentioned before, is now and has been for the last decade or more by far the most commonly known and most widely used protective atmosphere. It is produced by the partial combustion of fuel gas with a limited and controlled supply of air. The unit for the preparation of this gas is often referred to as a "cracker." In the cracking of the fuel gas, a wide range of compositions may be obtained by variations in the air-gas ratio or the type of fuel gas used.

Table II shows a representative composition for each of two fuel gases commonly used to prepare a protective atmosphere:

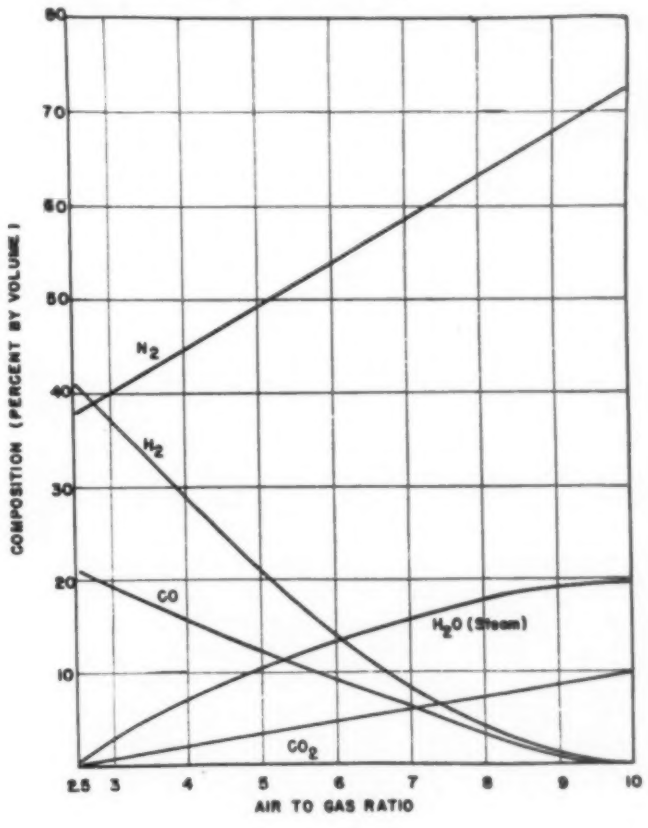
TABLE II
Representative Composition of Coke-Oven Gas and Natural Gas

	Coke-oven gas, per cent (Desulphurized)*	Natural gas, per cent
Carbon dioxide (CO_2)	1.3	0.1
Oxygen (O_2)	0.3	0.0
Carbon monoxide (CO)	5.5	0.0
Hydrogen (H_2)	56.5	0.0
Methane (CH_4)	28.3	92.3
Ethane (C_2H_6)	0.0	0.6
Other hydrocarbons	3.0	0.1
Nitrogen (N_2)	5.1	6.9
Approximate dew point	60 F	0 F

*Slight amounts of sulphur compounds can usually be found.

Figure 1 shows graphically the composition of one fuel gas with air to gas ratios from 2.5 to 10. The cracker is usually adjusted to supply a resultant gas of approximately 4 to 8 per cent carbon dioxide (CO_2), 7 to 11 per cent carbon monoxide (CO), 8 to 15 per cent hydrogen (H_2), 0.0 per cent oxygen (O_2) and 0.2 to 1.5 per cent methane (CH_4), the remainder being almost entirely nitrogen (N_2). The rather wide range of composition shown is deliberate in an effort to cover the numerous differences between the gases used by the various tin plate producing mills. Much has been written about the operation of these gas furnaces or crackers, therefore, we shall refrain from going further into that phase of the gas production except to say that the gas after cracking is dried either by cooling or by chemical driers. The dew point for this gas is usually controlled in the range of plus 32 to plus 50 F which is approximately 0.6 to 1.1 per cent water in the gas mixture.

Figure 1 — Composition of atmospheres for various fuel gas-air ratios is given by the graph.



The lean gas is a somewhat newer development in the production of protective atmospheres, having been used for only the last few years. It is produced with an air-gas ratio which approximates complete combustion of the gas after which the water vapor and the carbon dioxide (CO_2) are removed by drying and absorption respectively, resulting in a gas of approximately 2 to 3 per cent carbon monoxide (CO), 2 to 3 per cent hydrogen (H_2) and the remainder being almost entirely nitrogen (N_2). The dew point of this gas is usually controlled below minus 40 F, with less than 0.05 per cent water being allowed to remain in the gas mixture.

The nitrogen-hydrogen gas is also quite new in its use as a protective atmosphere for tin plate annealing. Recently its advantages have been examined by several tin plate producers, and it is possibly being used to some extent by some of these mills at present. This gas consists of 2 to 5 per cent hydrogen (H_2) and 95 to 98 per cent nitrogen (N_2) with a dew point controlled below minus 40 F.

This gas can be produced through the use of by-product nitrogen of acceptable purity from a liquid oxygen plant. This nitrogen gas consists of approximately 99.8 per cent nitrogen (N_2) with up to 0.2 per cent oxygen (O_2). The nitrogen (N_2) is mixed with hydrogen (H_2) or dissociated ammonia and passed through a catalyst which converts all of the excess oxygen (O_2) to water, after which the gas is dried to the desired range. The resultant gas consists of 95 to 98 per cent nitrogen (N_2) and 2 to 5 per cent hydrogen (H_2). Sufficient hydrogen (H_2) is maintained to prevent oxidation of the steel through normal diffusion of gases.

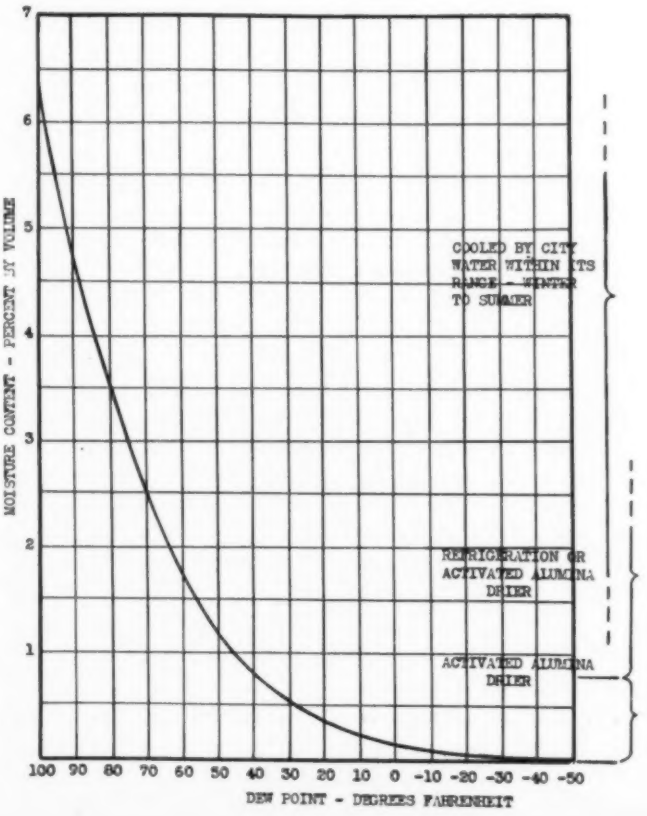
Nitrogen-hydrogen (NH) gas may also be produced by other methods, one of which consists of passing lean (NX) gas over a catalyst at a temperature of from 800 to 900 F in the presence of excess steam which oxidizes most of the carbon monoxide (CO) to carbon dioxide (CO_2). The carbon dioxide (CO_2) is then removed by absorption. This gas will have approximately 5 to 6 per cent hydrogen (H_2) since hydrogen is produced in the oxidation of the carbon monoxide. Approximately 0.1 to 0.2 per cent carbon monoxide (CO) may remain in this gas. Another method for the production of a very similar gas is by the complete combustion of the fuel gas, the removal of the carbon dioxide (CO_2) and the addition of approximately 2 per cent hydrogen (H_2) or sufficient dissociated ammonia to supply 2 per cent hydrogen (H_2). This gas would differ from the above in that it would contain approximately 0.25 to 0.50 per cent carbon monoxide (CO). Both gases would be dried to below minus 40 F dew point.

Since moisture content must be controlled to a rather close degree because of its oxidizing effect on the steel, it became apparent early in the use of these gases that auxiliary drying equipment was needed. The condensation of the moisture by refrigeration is quite successful down to approximately 38 to 40 F, but the use of much lower temperatures than this results in freezing of the water on the cooling coils. Lower dew points may be obtained by the use of activated alumina driers. Two drying units are used alternately, one drying the gas while the other is being reconditioned. This cycle is reversed about every eight hours. Figure 2 illustrates the per cent of moisture and the corresponding dew point. The removal of the carbon dioxide (CO_2) is accomplished by chemical absorption, passing the gas through monoethanolamine.

The complexity of the gas reactions during the heating and cooling cycles, particularly in those protective atmospheres containing carbon monoxide (CO) and carbon dioxide (CO_2) has long been recognized throughout the industry. Much has been written regarding these reactions and much progress made toward maintaining a sufficiently balanced gas to produce a clean and unetched surface. Today little difficulty is encountered by any tin plate producer in attaining a full bright strip. However, during the past few years, controlled atmospheres for annealing tin plate have taken on new responsibilities. Investigations have indicated that the corrosion resistance of the finished tin plate is related to some extent to the type of protective atmosphere used during the annealing. This phenomenon has been under investigation for some time now and is still under active investigation.

The corrosion resistance of tin plate may be explained as that protective quality of the plate which determines the length of time it will hold foods in the packed can before failure. This is also referred to as "shelf life." A rather large amount of corrosion testing is being done by a number of can manufacturers' research departments and by a number of the tin plate producers' research departments. Many foods are used in these pack tests, prunes being probably the most common. Foods are sealed in cans made from the samples under study and the storage tests are conducted at both room temperature and elevated temperatures. These tests are important in evaluating the effect of many variables such as the amount of the tin on the base metal, the type of the steel base metal, the type of food packed, and numerous mill processing variables, one of which is the type of protective atmosphere used in the annealing of the steel.

Figure 2 — Graph gives dew point for various moisture contents.


MOISTURE CONTENT - PERCENT BY VOLUME
7
6
5
4
3
2
1
COOLED BY CITY WATER WITHIN ITS RANGE - WINTER TO SUMMER
REFRIGERATION OR ACTIVATED ALUMINA DRIER
ACTIVATED ALUMINA DRIER
100 90 80 70 60 50 40 30 20 10 0 -10 -20 -30 -40 -50
DEW POINT - DEGREES FAHRENHEIT

This problem of increasing the corrosion resistance of tin plate of any given coating weight class is of much interest to the tin plate producers, the can manufacturers, the packers, the storekeeper and the housewife. The problem has been quite critical during this past decade because of the wartime restrictions on the use of tin. Most foods were packed during the war years in containers with less tin coating than had been the normal practice prior to 1940. The search for a way to increase the corrosion resistance of tin plate is of paramount importance to can maker and tin plate producer alike.

These investigators pack tens of thousands of cans annually, possibly exceeding the hundred thousand mark in order that the effect of these many variables may be better understood. Through the guidance of this information many marked improvements have been made in the corrosion resistance of tin plate during the past twenty years.

Since it takes months to determine the corrosion resistance of tin plate by the pack tests, considerable interest has been shown in a test for a more rapid evaluation of this factor. Much work has been done and many things have been tried, only a few of which include potential measurements, immersion of samples for given periods of time in various food media, and controlled measurement of hydrochloric acid attack. The more promising of these tests are under constant study. The perfection of a dependable rapid test will prove of inestimable value to the tin plate industry.

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DISCUSSION

PRESENTED BY

C. CONE, Surface Combustion Corp., Toledo, Ohio

J. R. TRIMBLE, Assistant Manager, and J. E. HILL, Metallurgical Engineer, Tennessee Coal, Iron and Railroad Co., Birmingham, Ala.

C. Cone: The T.C.I. laboratories have done some very important pioneering work in the development and commercial application of new types of annealing atmospheres. Thanks to this and other innovations in quality control, I understand that they are now turning out a very high quality of electrolytic tin plate. These authors have modestly refrained from acknowledging their part in that development.

On the assumption that this subject is of immediate interest, we would like to add some information regarding practice in other mills which, for the time being, had better be anonymous. We recently had a call from a chemical engineer engaged in the development of organic lacquers for tin can linings. He had been studying results secured in the application of such lacquers to electrolytic tin plate secured from various sources, and asked for our help in explaining some of the remarkable discrepancies observed. As he explained, all samples were identical in appearance before application of the lacquer. After lacquering, however, there was a decided difference in both appearance and corrosion resistance on portions of samples corresponding to edges of the original tin plate strip. On the product from mill "A," edges were consistently bad. Material from mill "B" was decidedly better, but still showed occasional differences between edge and center. He then advised that materials from source "C" during the past few months had been almost entirely free from edge defects. He asked if this difference could be accounted for by difference in annealing atmospheres.

We happen to know that mill "A" is still using DX gas for electrolytic tin plate. Mill "B" converted to NX gas about two years; whereas, mill "C," within the past few months, has used a modified NX gas containing no carbon monoxide, which we term HNX gas. I think these results show more than a coincidence.

Since the installation of the HNX gas generating equipment in mill "C," a considerable amount of test work has been done to compare annealing results with the three atmospheres in question on this particular product. A good deal of this work cannot be reported at this time. However, I imagine that the interested members of this audience are familiar with the pickle lag tests for surface cleanliness of tin plate strip before coating. The results of hundreds of such tests showed a very definite grouping of results for the three gases, with NX decidedly superior to DX and HNX, in turn, showing a clear cut improvement over NX. Equipment for manufacturing HNX gas is now in commercial operation, making a gas with a carbon monoxide concentration of around 0.05 per cent. With fuel gas costing $0.40 per million Btu, the gas is produced at an operating cost of about $0.12 per thousand cubic feet of finished volume.

There has been a lot of speculation as to why these various atmospheres show such drastically different results in tin plate annealing. We are still guessing at the real answer. However, we found in some very careful tests, involving precise analysis of atmosphere entering a coil annealing stack and the atmosphere leaving the same stack, that with DX gas the atmosphere deposits carbon in the load. With NX gas the effect is almost neutral. With HNX gas, containing no CO, a substantial amount of carbon is actually removed from the load, showing up as carbon monoxide and hydro-carbons in the effluent gas.

We are currently considering continuous annealing as a means of improving surface quality of strip intended for electrolytic tin plate. I would like to ask the authors if, in their opinion, the possibilities of these new annealing atmospheres for coil annealing make the potential advantages of continuous annealing less attractive than they were a year or two ago.

J. R. Trimble and J. E. Hill: The true relationship of annealing atmosphere to tin plate surface quality in continuous annealing is a subject on which there is little definite information. With the exception of one tin plate producer who, insofar as we know, has used only one type of protective atmosphere, there is no experience in this country in continuous annealing of tin plate, and any answer to Mr. Cone's question would be based on opinion rather than factual data.

TUNGSTEN CARBIDE ROLLS FOR COLD ROLLING METALS

By R. T. BEEGHLY
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. . . . tungsten carbide rolls can be used at speeds double that of normal practice . . . . their use may require changes in operating practice such as amount of reduction, annealing cycle, roll shape, etc. . . . .

▲ MOST of us are aware of the widespread use and acceptance of tungsten carbide metal in the metalworking industry during the past two decades. World War II gave tungsten carbide a tremendous boost. The use of carbide cutting tools, drawing dies and wear resistant parts on machinery and equipment is fairly commonplace today.

It was natural, therefore, that some thought and attention would be given during this period to utilizing this ultra-hard, dense and compact metal as a roll for cold rolling other metals. Increased rolling speeds, greater reductions and the development of harder alloys had intensified the search for new roll materials. Tungsten carbide seemed to possess all of the desired properties — maximum hardness, extreme density, a strong compact structure, freedom from porosity, and a particularly smooth, uniform and lustrous surface.

The principal obstacle in the early 1930's was the lack of a manufacturing process capable of producing carbide pieces of large enough size for use as rolls. The sintering process used to make tool tips, die nibs and other small parts, which American producers had adopted in the middle 1920's from Germany, could only produce pieces of relatively small size on the order of 4 or 5 lb. It was evident that a new method was needed for handling the powdered metals used in making tungsten carbide — a method that would eliminate size restrictions and make possible the production of carbide rolls weighing up to 1000 lb or more. An extensive research program was initiated by one American carbide producer, which after five years and the expenditure of hundreds of thousands of dollars resulted in a perfected and commercially sound process of molding large masses of powdered metals under heat and pressure into solid form. This process became known as the hot press method.

The first pair of solid tungsten carbide rolls made by this method, which gave satisfactory service, was installed on a 4-high cold rolling mill in 1934. These rolls weighed 50 lb each, measured 2½ in. in diameter × 16½ in. overall length with an 8½-in. face, and successfully cold rolled low carbon, high carbon, stainless and several types of alloys. It is interesting to note that this was the first time that steel strip had been cold rolled with a material of unlike or dissimilar properties, as heretofore steel strip had always been cold rolled with iron or steel rolls. Substantial progress has been made since this initial experiment, and today approximately 50 plants throughout the country have carbide work rolls installed on various types of cold rolling mills, including 2-high, 3-high, 4-high and cluster-type. Sufficient experience has been gained in the cold rolling of many types of metals to reach certain conclusions regarding the practicability of using carbide rolls. After a brief description of how carbide rolls are manufactured, this paper will discuss the advantages and disadvantages of using carbide rolls and current mill practices and standards as established by carbide roll users.

METHOD OF MANUFACTURE

Tungsten carbide rolls are a laboratory produced product — made by powder metallurgy methods. The raw materials used in making them are tungsten, cobalt and carbon, all in fine powdered form. High grade metallic oxides of tungsten and cobalt are reduced in continuous muffle-type furnaces using a pure, dry hydrogen gas atmosphere — the tungsten at a temperature of around 2000 F and the cobalt at 1800 F. Metal powders are thus produced of very high purity. Extreme care is taken during reduction to produce metal powder having the finest possible particle size. A mixture consisting of 94 per cent tungsten metal powder and 6 per cent lampblack or carbon is next carburized in a closed crucible-type high frequency electric furnace at a temperature of 2800 F. This action results in the formation of tungsten carbide particles of microscopic size. These particles are then passed through a series of crushing, ball-milling and screening operations with the pulverized powder being finally separated into different classifications as to particle size and shape. At this point, the average particle size of the powder ranges from 1 to 15 micron which is equivalent to 1,000 to 12,000 mesh. The average cross-section of the powder particle measures forty millionths of an inch (0.00004) or 1/50 the thickness of a human hair. A powder mix is next prepared consisting of predetermined amounts and percentages of different size and shape particles which are intermixed and blended together. To this

mixture is added approximately 8 per cent of cobalt metal powder which serves as a binder and cements the tungsten carbide particles together during the subsequent hot pressing operation. Final blending produces a uniform mixture of powdered metals having the proper ratio of particle sizes to obtain maximum strength and a uniform structure in the finished roll. On applications where the roll surface will be subjected to excessive "pick-up" and "galling," titanium carbide powder in amounts up to 10 per cent is usually added to the mixture.

The prepared powder mixture is thoroughly dried in a closed oven-type electric furnace to remove all traces of moisture and to prevent oxidation. The proper amount of powder is determined and weighed out to the nearest gram — the carbide industry being one of the few American industries using the metric system of weights and measures. A crucible or mold, machined from carbon or graphite, is prepared and the powder is loaded into same under heavy vibration. The cavity in the mold is similar in shape and diameter to the roll to be formed, but in length it is approximately 2½ to 3 times longer than the length of the finished roll. The loaded mold is placed inside an electric-induction coil operated in conjunction with a motor-generator set of 200 kw capacity or larger. As the mold develops heat by induction, pressure is applied to the powder mix through carbon or graphite plungers hydraulically operated. The mass of loose metal powder is thus compressed and reduced during hot pressing into a solid metallic structure only 30 to 40 per cent as long as the original powder mass. This amount of reduction in volume produces a tungsten carbide structure of unusual density and compactness. The hot pressing operation of simultaneously heating and pressing metal powders into solid form is accomplished with a pressure of 2000 psi and a temperature ranging from 2800 to 3000 F. The constant pressure maintained on the metal powder during the heat, uniformly fills out all cavities and voids and prevents the formation of gas pockets in the roll. Sufficient pressure is continued during the cooling period after hot pressing to prevent swelling and to maintain size and density.

The proper synchronization of heat and pressure during the hot pressing operation is extremely important and is controlled by electric-eye detectors and special temperature and pressure gages that closely regulate these factors during soaking, heating and cooling time. Among the special factors that have to be controlled during hot pressing in order to produce a satisfactory roll structure are: powder flow, atmospheric conditions, gas formations, oxidation, unequal distribution of the cobalt binder (which has a lower melting point than tungsten carbide), variable density, porous spots, and excessive re-crystalization. Laboratory control all through the hot pressing cycle is vital and necessary in order to regulate all of these operating variables. Tungsten carbide metal, once formed into a solid structure, cannot be annealed, tempered, drawn, heat treated or reworked into another size or shape. Neither can it be used in the form of scrap as a raw material in another heat. Being without salvage value, and due to the high cost of raw materials, (which average $5 per lb), the technique of making tungsten carbide has been developed to an exceptionally high degree of quality control and precision methods.

After hot pressing, the graphite mold is broken apart and the roll extracted. The average roll has a density of 14.8 compared to heat treated high speed steel, which has a density of 8.6. Tungsten carbide has a theoretical weight of 240 grams per cu in. (or roughly ½ lb). The hardness of tungsten carbide rolls is determined by use of a Rockwell hardness tester using a diamond penetrator under a 60 kilogram load — the average hardness being 91–92 Rockwell "A" which is equivalent to 80 on the Rockwell "C" Scale or 120 Shore scleroscope. In addition to checking the density and hardness values, the third most common check on the physical properties of carbide is the transverse rupture strength — the average carbide roll having a value of 275,000 psi. A microscopic examination of the surface is common procedure, a magnification of 500 to 1 being used for checking porosity and 1500 to 1 for checking grain size and structure.

GRINDING TECHNIQUE

A specialized grinding technique has been developed for grinding and polishing carbide rolls. Resinoid-bonded diamond wheels of medium grade hardness and 100 diamond concentration are used to remove the scale and grinding stock which normally averages 0.030 to 0.060 in. per side. A 100 grit diamond wheel is used for roughing. A 400 grit wheel is used for semi-finishing, to eliminate all scratches and to provide a base for subsequent polishing. The above operations are performed using a water coolant mixed with 1 per cent of a good quality grinding oil. Finish grinding is accomplished with a 600 grit wheel using plain water. All of the above wheels are operated at 5000 to 5500 surface feet per minute. Lapping and polishing of the roll face is accomplished by hand application of a wood lap saturated with 4–8 micron diamond powder and alcohol. An exceptionally brilliant, lustrous surface finish is developed on the roll face — the color being dark

Figure 1 — This sleeve roll is used for flat wire.

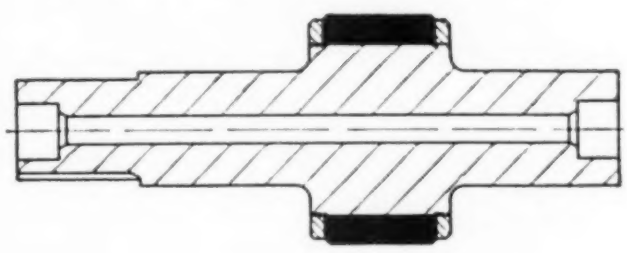
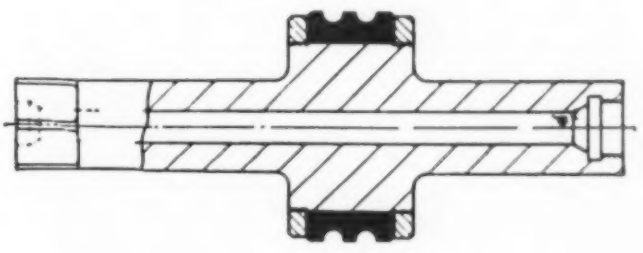


Figure 2 — This sleeve roll is used for shaped wire.



blue-black with a glossy texture. The optimum degree in flatness and smoothness, which is inherent in the carbide roll surface, is evidenced by profilometer tests which show a surface variation of less than half a millionths of an inch (0.0000006 in.). The roll grinder, spindle, grinding wheel, centers, and roll neck supports must of course be in as perfect condition and balance as possible to achieve the above results.

ROLL DESIGN

Two types of basic roll designs are used in adapting carbide rolls for cold rolling metals — these being either of solid or sleeve-type construction. For cold rolling strip wider than ½ in. rolls having a solid carbide body and solid carbide necks are usually recommended, particularly when used on 4-high or cluster-type mills where the rolling pressures are greater.

Solid carbide rolls are generally similar in shape, size and design to steel work rolls. All corner radii should be as liberal as possible and sharp corners avoided. Diameter of roll necks should be as large as possible and not less than 60 to 65 per cent of the roll body diameter. If insufficient space is available to accommodate full bearings on the journals, the hard, smooth and wear resistant carbide necks are an excellent substitute as inner races when using ball, roller or needle bearings. The anti-friction properties of carbide necks also make them ideal as bearing seats for sleeve bearings. The ratio of body length to body diameter should not exceed 4 to 1. Rolls exceeding this ratio present more manufacturing problems and have lower strength values. After initial lapping, the centers in a solid carbide roll maintain size indefinitely and simplify the problem of holding concentricity and tolerance during subsequent regrindings. Solid carbide rolls can be used satisfactorily as either idle or driven rolls. The torsion strength of solid carbide rolls is superior to carbon steels and only slightly inferior to alloy steels, although as a safety factor, torque loads should be slowly applied and sudden heavy loads avoided. The tensile strength of carbide rolls ranges from 125,000 to 150,000 psi. Hexagon and octagon sided wobblers have been used successfully and are preferred over conventional square or four-sided wobblers due to their greater area, cross-section and strength. Solid carbide work rolls in use range in size from ½ in. diameter × 4 in. face up to 4 in. diameter × 30 in. face. Rolls in diameters up to 24 in. and lengths up to 40 in. can be produced with existing equipment, the largest weighing in excess of 1000 pounds.

For cold rolling flat or shape wire from round wire, or when rolling metal tinsel or ribbon, a carbide sleeve is usually press fitted to a steel arbor. Since the thermal expansion of carbide is about half that of steel, the roll arbor should be made of a special grade of nickel steel having the lowest possible expansion properties, such as invar steel. Another special steel on the market, developed primarily for use as a roll arbor for carbide sleeves, contains 49 per cent nickel with a small amount of columbium. It has the same coefficient of expansion as carbide metal, can be hardened to 33–38 Rockwell "C," can stand a fairly heavy torque load, and has proven generally satisfactory. Anti-friction bearings are preferred as supports for this type of arbor. The carbide sleeve is lapped on the inside diameter and press fitted to the steel arbor using a tolerance of 0.0001 in. A keyway is provided to prevent slippage of the sleeve. Threaded steel collars are usually positioned on both sides of the carbide sleeve and anchored with set screws. Since carbide outwears steel many times, it has been common practice to use a narrower carbide sleeve and fill out the roll face to its original width by adding steel collars. A liberal chamfer is provided on both edges of the carbide sleeve. On applications requiring a roll arbor hardened to 60 Rockwell "C," high carbon steel alloys containing chrome or nickel have proven satisfactory. However, when using this type of steel, internal water cooling of the arbor is a necessity in order to maintain temperature and prevent excessive arbor expansion which would crack the outer carbide sleeve. An efficient water cooling system coupled with the low thermal expansion properties of carbide rolls make it possible to roll flat and shape wire and metal ribbon to extremely close dimensional limits, with tolerance held to 0.0001 to 0.0002 in. One producer is rolling steel ribbon down to the unbelievable size of 0.0005 in. thick × 0.001 in. wide. The minimum wall thickness of carbide sleeves should be ⅝ in. for 4 in. diameter rolls, ¾ in. for 6 in. diameter rolls and 1 in. for 8 in. diameter rolls. Under favorable conditions, carbide-sleeved rolls can also be used on 2-high or 4-high mills for planishing or final finishing strip to a high lustre providing reduction per pass does not exceed 0.0005 in.

OPERATING DATA

Solid carbide rolls are being used for cold rolling all common types, grades and analyses of strip steel, including low carbon, high carbon, alloy, spring, razor, silicon and stainless. It has been general practice to operate carbide rolls at the same rolling speeds as used for steel rolls, although carbide rolls can be operated up to double conventional speeds without affecting roll life. Rolling speeds average 1200 to 1500 fpm with certain applications exceeding 2000 fpm.

Common finishes used on carbide rolls are 180 grit, 400 grit and 600 grit polished to a high lustre. On strip where slippage occurs, a 180 grit finish is recommended. Bright finish strip is being regularly produced with carbide rolls having a surface variation of less than 3

Figure 3 — The smooth finish of the carbide rolls can be seen from this photograph.

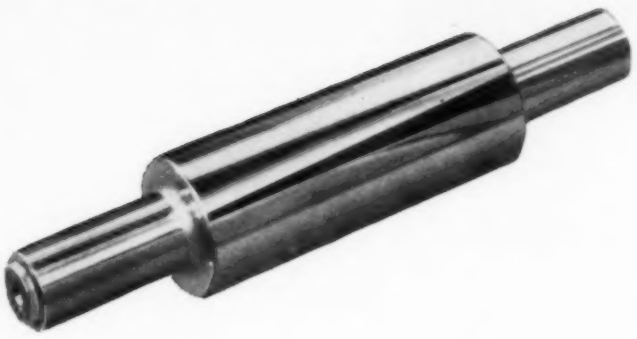


Figure 4 — The final roll is compressed and the density increased markedly in the manufacturing operation.

millionths of an inch (0.000003 in.) or approximately twice the flatness and smoothness of strip rolled with steel rolls. Gage and tolerance are held within closer limits, which adds more usable length per coil and reduces waste. The high modulus of elasticity value of 95,000,000 psi for carbide rolls, which is about three times that of steel rolls, accounts for the extremely rigid and low deflection properties of carbide rolls. Platers report that only ⅓ to ½ the normal amount of tin, copper, nickel, cadmium or other plating material is required to plate carbide rolled steel. Manufacturers of stampings find that the working edges of steel punches and dies last twice as long when used on carbide rolled steel because the smoother and higher polished surface imparted on the strip is less abrasive. The bright finish produced by carbide rolls eliminates the need for further buffing or polishing and is retained during the annealing operation. Carbide rolls have a much lower coefficient of friction property than steel. Pickup, scoring, scratching and galling is either eliminated or substantially reduced.

The amount of reduction taken per pass also closely follows established practice with steel rolls. From 25 to 35 per cent reduction is usually taken on the first pass — 10 to 20 per cent on subsequent passes — with 15 per cent being the average. It has been determined however that from 10 to 20 per cent more reduction per pass can be taken with carbide rolls than is possible with steel rolls, and with less power being required in proportion. The compressive strength of carbide rolls is higher than for all melted and cast or forged metals and alloys, having a value of 750,000 psi compared to 600,000 psi for heat treated high speed steel. Due to the ability to withstand compression under heavy loads and pressures, carbide rolls readily bite into thin gage strip under 0.012 in., rolling same down to as thin as 0.001 in. Under similar conditions, steel rolls will not function since they flatten out and lose their biting power. The combination of compressive strength and extremely hard structure gives carbide rolls exceptionally long life between grinds, outlasting steel rolls from 50 times longer on low carbon steel up to 15 to 20 times longer on hard alloys and stainless steel. On some applications it has been observed that a steel and carbide roll mated together are the solution to certain rolling problems where neither carbide or steel rolls alone proved satisfactory.

Experience to date does not indicate that much change is required in the annealing cycle, although some users report that the strip work hardens and stiffens up faster with carbide rolls making it necessary to change the annealing point. Also, a more rapid rise in temperature in the strip and back-up rolls has been noted by some carbide roll users which required changes in both the reduction and annealing cycle.

When installing solid carbide rolls, it is important that the back-up rolls be redressed and that the strip be as flat as possible. Particular attention must be given in setting up the rolls to avoid misalignment. Steel rolls will bend and deflect sufficiently to accommodate an unfavorable load or slight misalignment condition. However, rigid carbide rolls have a very low conformability property and they will not bend or move sufficiently to correct misalignment and same will show up in wavy or rippled strip, edge cracks, slippage and other defects. It is not advisable to install carbide rolls after taking initial passes with steel rolls as trouble will invariably result due to variations in temperature and since the shape of the strip would not match that of the carbide roll. Conversely, steel rolls can be installed at any stage in the cold rolling cycle to replace carbide rolls without experiencing difficulty. As a safety factor, the strip should be kept at least ¾ in. from the ends of the roll body, flat wire at least ½ in. Provision should also be made to prevent the rolls from cracking together at the end of the run.

The same rolling oils are used for carbide rolls as for steel rolls, common lubricants being mineral oil, palm oil, kerosene, alcohol, lanolin and soluble oil with water. On applications where reductions are greater and particularly where harder alloys are being rolled, it has been found that a rolling oil with more body and film strength is required. Since carbide rolls do not flatten out to the extent steel rolls do, reduction is accomplished over a smaller area of contact which tends to build up more friction and heat. Carbide rolls are being used successfully both wet and dry. On dry grinding carbide rolls show up to particular advantage as they hold their polish 10 to 15 times longer than steel rolls.

The majority of carbide rolls are used flat as no crown is needed to compensate for bending or deflection. However, to accommodate strip steel having a crown or other shape and to provide for temperature changes in the strip and in the back-up rolls, carbide rolls are occasionally hollow ground from 0.0002 to 0.002 in. Hollow grinding is also used to match the work rolls with worn back-up rolls. Less use is made of a crowned roll and if used, the crown on the carbide roll is normally ¼ the crown used on a steel roll. Carbide rolls can generally be ground flat, crowned or hollow ground, cheaper than steel rolls, principally because they require fewer regrinds. The higher price of the diamond wheel is offset by the shorter grinding period as only 0.0005 in. is removed per grind compared to 0.002 in. for steel rolls. When rolling gold, silver, platinum and other precious metals, special attention must be given to developing the proper roll shape, because in the absence of tension and guides, side slippage of the strip is likely to develop.

Carbide rolls with spalled out sections, cracked bodies or broken necks can usually be repaired by powder metallurgy methods at approximately 1/10 to 1/5 the cost of a new roll — something not possible or practical with broken or damaged steel rolls.

The operation of carbide-sleeved rolls follows closely the practice used with steel rolls as to rolling speeds, amount of reduction, lubricant, and annealing cycle. Speeds average from 100 to 500 fpm with several installations operating at 1500 fpm. Amount of reduction per pass ranges between 20 and 40 per cent depending on hardness and analysis of flat wire rolled. In addition to rolling all common grades and analyses of steel flat wire, carbide rolls have also given good performance on special grades of wire, including silver plated copper, nickel plated copper, nickel plated steel, phosphor-bronze, beryllium copper, nickel, tantalum, molybdenum, monel, nichrome and brass. Grooved carbide rolls have proven satisfactory for rolling wire having special shapes and contours. As a general rule, the amount of flat or space between each groove should be twice the width of the groove to provide adequate strength and support. Oscillation of the wire back and forth across the roll face is recommended to conserve life of the roll, to minimize pickup and scoring and to reduce downtime. The four principal advantages stressed by users of carbide rolls for rolling flat and shape wire are a much finer surface finish, closer tolerances held on dimensional limits, reduced expense for servicing rolls, and less mill downtime.

It is particularly important that the wire being fed into the mill be as clean as possible and free from dirt, scum and foreign matter. Rough or oxidized wire will groove carbide rolls when subjected to excessive pressures. Carbide-sleeved rolls also tend to build up temperature faster than steel rolls because of their greater flattening effect on the wire and because the transmission of heat is slowed down at the point where the outer carbide ring adjoins the inner steel arbor. Dirt and foreign matter tends to build up on the warmer, smoother surface of the carbide roll and for this reason cleanliness is essential, particularly when rolling dry. An efficient water cooling system with temperature control unit also helps prevent caking of dirt on the roll surface. With favorable operating conditions, users report continuous service life without regrinding from several months to a maximum of two years, or roughly from 10 to 50 times longer than possible with steel rolls.

More attention is now being given by rolling mill manufacturers to mills primarily designed to accommodate carbide rolls. Cluster-type mills which use relatively small diameter work rolls in comparison to other type of mills are particularly well adapted for carbide roll application, from both a cost and design standpoint. Torsional strains are kept to a minimum since the carbide work rolls are not driven and are rigidly supported by multiple back-up rolls. One producer has recently announced a new precision 4-high reversing cold rolling mill built around solid carbide rolls which features driven back-up rolls that drive the smaller work rolls throughout the full width of their face. Power applied in this manner prevents distortion of the work roll from twisting as is the case with conventional neck driven work rolls. Lateral distortion is also eliminated. In addition to improving rolling technique these design changes also favor the weaker, more brittle carbide roll.

Past experience has shown that every carbide application must be designed and engineered from the standpoint of giving maximum support and backing to the more brittle carbide metal. If engineered properly, and more than ordinary care and precaution is taken in use, results far exceed the cost and breakage and failure of the carbide is prevented.

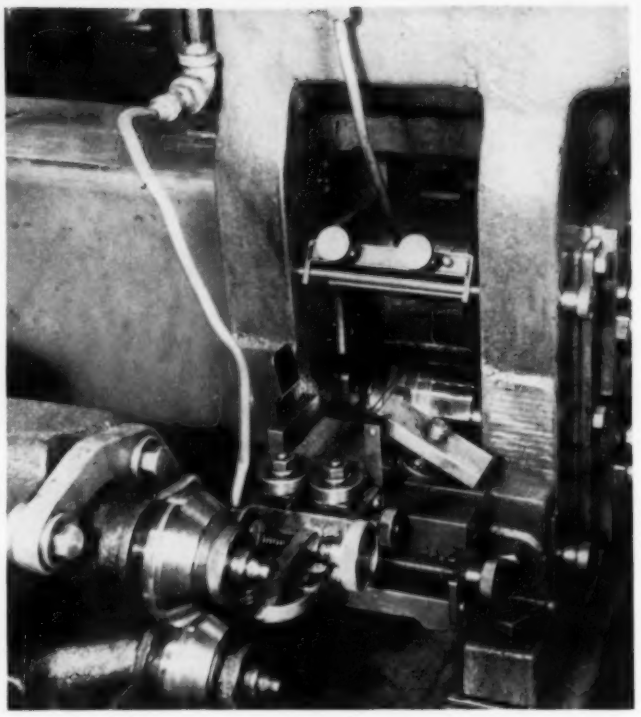


Figure 5 — The rolls shown are carbide sleeves which are grooved to roll a shaped wire.

Some plants have been able to substitute carbide rolls in place of steel rolls and secure satisfactory production with little or no change in operating procedure. However, it should be pointed out that carbide rolls are a totally new medium for cold rolling metals, they have their own distinct properties and peculiarities, and the average carbide roll user has found it necessary to change at least to some degree the rolling speed, amount of reduction per pass, annealing cycle, roll shape and other operating procedure. An initial period of trial runs under variable conditions is usually required to familiarize plant personnel with the specific changes necessary to obtain maximum results and efficiency. A small group of experienced plant personnel should be given the responsibility of installing and using the initial pair of carbide rolls. A definite program of rules and operating standards to fit the particular company involved should be worked out governing the use of carbide rolls before they are turned over to less experienced work crews.

The broader application of carbide rolls to the cold rolling of metals will undoubtedly parallel the experience of the metal-working industry when adopting carbide cutting tools and drawing dies over the past 20-year period. A comprehensive program of education and "know how" will have to be developed, changes in equipment design and operating practice will have to be determined and made, and new standards established for the particular category of cold rolling applications on which carbide rolls can be satisfactorily used. Enough progress has been made to date to definitely establish carbide rolls as a medium for cold rolling metals, and to indicate a broader application in the future for this hardest of man-made metals.

DISCUSSION

PRESENTED BY

L. L. WILSON, Engineering Consultant, Cold Metal Products Co., Youngstown, Ohio

D. W. LLOYD, General Superintendent, Youngstown Sheet & Tube Co., Youngstown, Ohio

R. T. BEEGHLY, Vice President and General Manager, Metal Carbides Corp., Youngstown, Ohio

BRYANT BANNISTER, Consulting Engineer, National Tube Co., Pittsburgh, Pa.

JOHN L. YOUNG, Vice President-Chief Engineer, United States Steel Co., Pittsburgh, Pa.

L. L. Wilson: Our experience has been rather varied and, for our type of product and for our type of mill, experimentation has been very worthwhile. We undoubtedly use more carbide rolls than any other cold roller in the business. The older steckel mills, and our more recent mills using driven back-up rolls, lend themselves perfectly to the development and use of carbide rolls.

Mr. Beeghly mentioned the optimum attainable degree of smoothness of less than half a millionth of an inch surface variance as indicated by a profilometer. It is of course not necessary to spend grinding time to attempt to attain this perfection. While admittedly it takes more care and perfection of technique to grind carbide rolls, our own roll grinders, with practice, have become proficient in this work and regularly turn out a satisfactorily ground carbide roll, after it has seen considerable mill service, in about the same length of time as is normally put on grinding an alloy steel roll. However we measure our carbide finish at approximately 3 microns, to compare with the profile on a well ground mirror finished steel roll at 6 to 10 microns or more. The 3 micron finish will do a beautiful job in producing high luster finishes on carbon, alloy, stainless steel or brass.

The material advantage of this finish, combined with roll hardness and wearing ability, is shown in the relative surface quality produced and in the time between grinds. As an example, one of our cold rolling fraternity produces a high luster stainless — at times. To make it he changes his mirror ground steel rolls about once for each coil finished. When carbide rolls were tried he found he was able to keep them in the mill for 56 hours of rolling time, and all during that time he produced better than average surface quality. We have had one pair of rolls in the mill, for varied amounts of rolling, on over 1200 consecutive coils, without regrinding.

As indicated by Mr. Beeghly, some thought must be given as to where and how these rolls are to be used and preventive care must be taken to avoid severe shock and torsion.

D. W. Lloyd: Mr. Beeghly stated that carbide rolls which are broken may be repaired. I would like to hear how this is accomplished.

R. T. Beeghly: When repairing broken carbide rolls, of course, the roll itself has to be in practically whole shape outside of line cracks. There cannot be a large area missing. In other words, there cannot be large sections broken out. Occasionally, in rolling, there will be an accident and a large crack will develop in the roll face and occasionally an entire neck will be broken off.

In cases of this type, it is possible to rework the roll through a similar process to that used when roll is initially made. It is placed in a graphite mold. The mold used in repairing the roll is much shorter than that used in making a new roll, because your compression has already taken place. The same temperatures are used. Time cycle is approximately half as long as when making a new roll. The hot pressing operation which is used in both making new rolls and in repairing broken rolls, irons out any defect in the roll surface, even if there should happen to be a large crack, or a check line in the face, or if the entire neck is broken off, or even if the roll body is broken clean through. It can be hot pressed back together and after regrinding there is no evidence whatsoever of any line.

This system of repairs has been used to some extent. We probably have reworked or repaired some twenty or thirty rolls in that manner. In adopting a new type of a material to a roll, there is, of course, more breakage when introducing these rolls into a plant in the initial periods, than there should be later, after more experience has been acquired, but the broken roll can definitely be repaired, and, as I stated, the cost runs something like one-tenth to one-fifth of a new roll.

Bryant Bannister: I would like to ask if these rolls can be made in other than cylindrical shape and to what maximum size you can make them?

R. T. Beeghly: The major part of the work done today has been confined to rolls for rolling shape wire and grooves in those rolls have not exceeded a half inch in width. There have been some rolls, in cold roll forming mills, where strips are formed into tube shapes, and tube shaped carbide rolls have been used on that type of mill with the grooves being three-fourths of an inch wide by roughly three-eighths of an inch deep.

All of the work to date and all of the applications to date have been on cold rolling applications. We have not had much experience, at all, in hot working, although we do have rolls on two applications involving the hot rolling of molybdenum and tungsten, and other alloy steels.

The problem connected with grooved rolls is that an appreciable amount of support has to be present. In other words, a grooved steel roll may have six grooves in it and it is sometimes necessary to reduce the number of grooves to, say four, in order to provide more width on the flat between the grooves to provide proper support.

You were asking about the size of the rolls. The largest roll in use by diameter is around twelve inches and the longest roll, counting the neck, is roughly forty inches. Rolls can be made up to twenty-four inches in diameter and up to forty inches in length.

John L. Young: How are the grooves in the rolls formed? Are they cast and then finished, or are they turned or ground from the cylindrical roll?

R. T. Beeghly: The rolls, as they come out of the mold, have roughly sixty thousandths of an inch stock on them and generally the grooves are ground from the solid. They are not moulded into the roll. We use diamond wheels exclusively for both roughing and finishing, diamond dust for polishing.

Power for Hot Strip Mills

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. . . . three trends in continuous hot strip mills are synchronous motors for roughing stand drives, rectifiers for finishing stand d-c power supply, and reversing type hot finishing mills . . . .

▲ HOT strip mills to produce long lengths of wide thin strip material are entirely a development of the last twenty-five years, and all but two or three of the mills now operating have been built, or completely rehabilitated, within the last two-thirds of that relatively short period. Development of the mills and of their electrical drives therefore have been quite intensive. The basic designs and general arrangements have become fairly well standardized, however, no two mills have exactly the same combinations of requirements, and thus the design of each new mill is made to meet the specific operating conditions, and to incorporate improvements found desirable from experience on earlier mills, and to take advantage of developments in mill and electrical equipment.

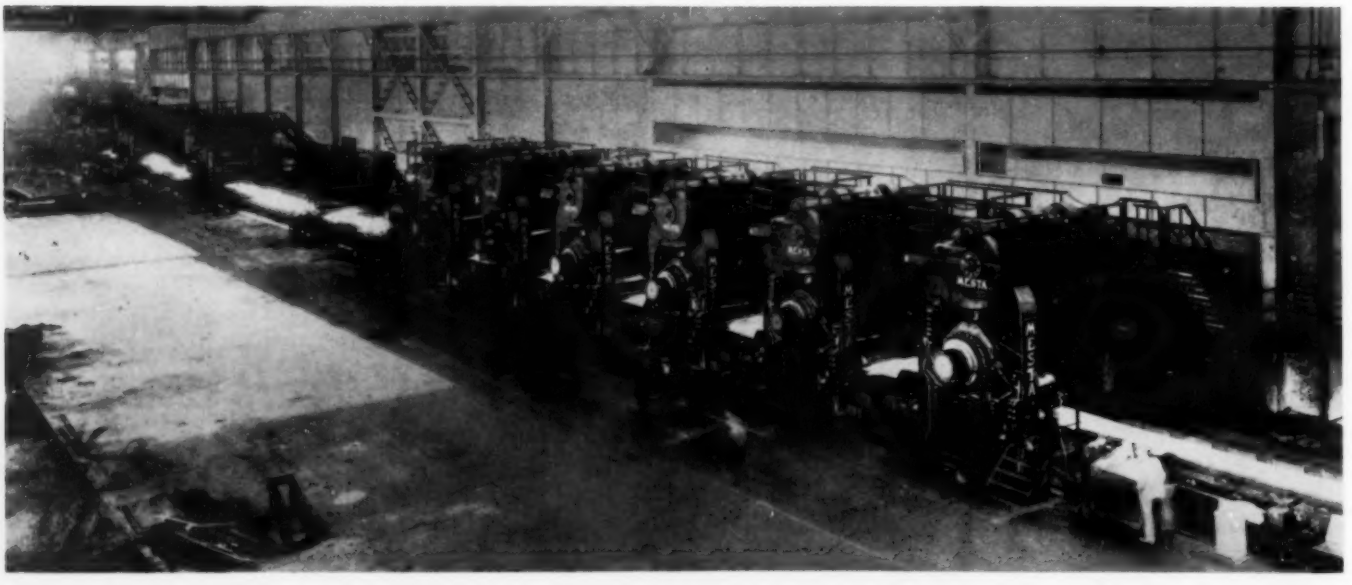
Many of the hot strip mill installations have been described in detail in articles published in the Iron and Steel Engineer, and numerous papers have been presented before the AISE on the subjects of power requirements, motor room design, systems of ventilation, electrical drive characteristics, etc. Therefore, these comments will cover only three particular items as exemplified in several recent installations.

1. Mill arrangement to enable rolling of large coils, and the resulting use of synchronous motors for roughing stand drives.
2. Use of ingitron rectifiers for finishing stand direct current power supply.
3. Installation of reversing type finishing mills for moderate tonnage production.

MILL ARRANGEMENT TO ENABLE ROLLING LARGE COILS

The newer cold strip mills have been designed to operate at extremely high speed, but the benefit of this high cold mill operating speed can be fully realized only when rolling long coils. The extremely large coils required for economical operation of high speed cold strip mills may be obtained by welding together several shorter strips during the pickling operation, how-

Figure 1 — This 76-in. continuous hot strip mill is one of the older units in service.



ever, the welded joints usually are inferior in strength to the parent strip and may break during cold rolling, or at least require more careful handling. Therefore, it is desirable to produce hot strip in the largest possible coils to reduce the number of welded joints and assure more nearly perfect cold mill operation. Recently constructed hot strip mills have been designed to produce such large coils.

Figure 1 shows one of the older 76-in. wide continuous hot strip mills, with the six finishing stands in the foreground and the four roughing stands in the background. Figure 2 shows the motor room for a similar 76-in. wide mill. In the foreground are the six 3500-hp, d-c motors driving the finishing stands and the two 6000-kw power supply motor-generator sets, and in the far background are the three 3000-hp and one 5000-hp induction motors driving the roughing stands.

Figure 3 shows the motor room for a more recent 56-in. wide mill with the six 3000-hp finishing mill motors and two 6000-kw main motor-generator sets in the foreground. Figure 4 is a view of the same 56-in. mill motor room taken from the opposite end and showing the four 3000-hp synchronous motors which drive the roughing stands.

Figure 5 shows the comparative plan arrangements of six different continuous hot strip mills, and indicates the progressive increase in spacing between the roughing stands to enable rolling larger slabs and thus finishing correspondingly longer strips and heavier coils. The three plans at the top of the figure are for wide—76, 98 and 80-in. mills, respectively, in which R-1 is a broadside stand to spread the slab and thus enable rolling strip wider than the available slabs. The three plans at the bottom of the figure are for narrower—43, 56 and 68-in. mills, in which the rolling is straightaway and the finished strip is approximately the same width as the starting slab.

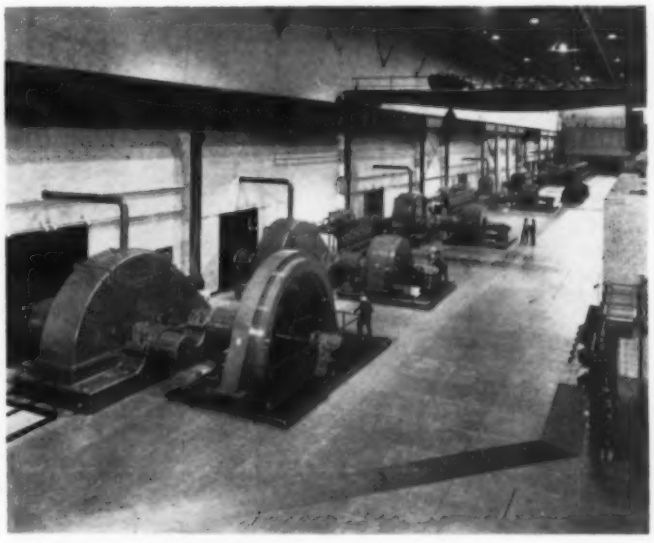
Plan "A" at the top of the figure is for a 76-in. mill, such as shown in Figures 1 and 2, installed in 1934, in which the total length of the mill from the roughing scale breaker to the last finishing stand is 392 ft-11 in., and the spacings between successive roughing stands and between the last roughing stand R-4 and first finishing stand F-1 are 40 ft-11 in., 46 ft-6 in., 70 ft-6 in., and 113 ft-8 in., respectively. Stands R-2, R-3, and R-4 all operate at about 410 fpm, and at this comparatively high speed and with the relatively short slabs which can be accommodated between roughing stands, the roughing passes are of only a few seconds duration. Thus each of the roughing stand drives includes a heavy flywheel, and each roughing stand is driven by a wound rotor induction motor with slip regulator secondary control to effectively utilize the flywheel effect.

As shown by plan "B" for a 98-in. mill installed a few years later, the spacings between successive roughing stands were all increased by 20 to 25 per cent to accommodate longer slabs between stands, also the broadside stand R-1 was made 110-in. wide (R-1 in plan "A" was only 96 in. wide) to permit turning and spreading a longer slab. On this mill, each roughing stand is driven by a 3000-hp wound rotor induction motor, however, flywheels and slip regulator secondary control are provided only on R-1, R-2, and R-3, and the

Figure 2 — Motor room for 76-in. continuous hot strip mill.

Figure 3 — Motor room for 56-in. hot strip mill from finishing end.

Figure 4 — Motor room of Figure 3 shown from roughing end.



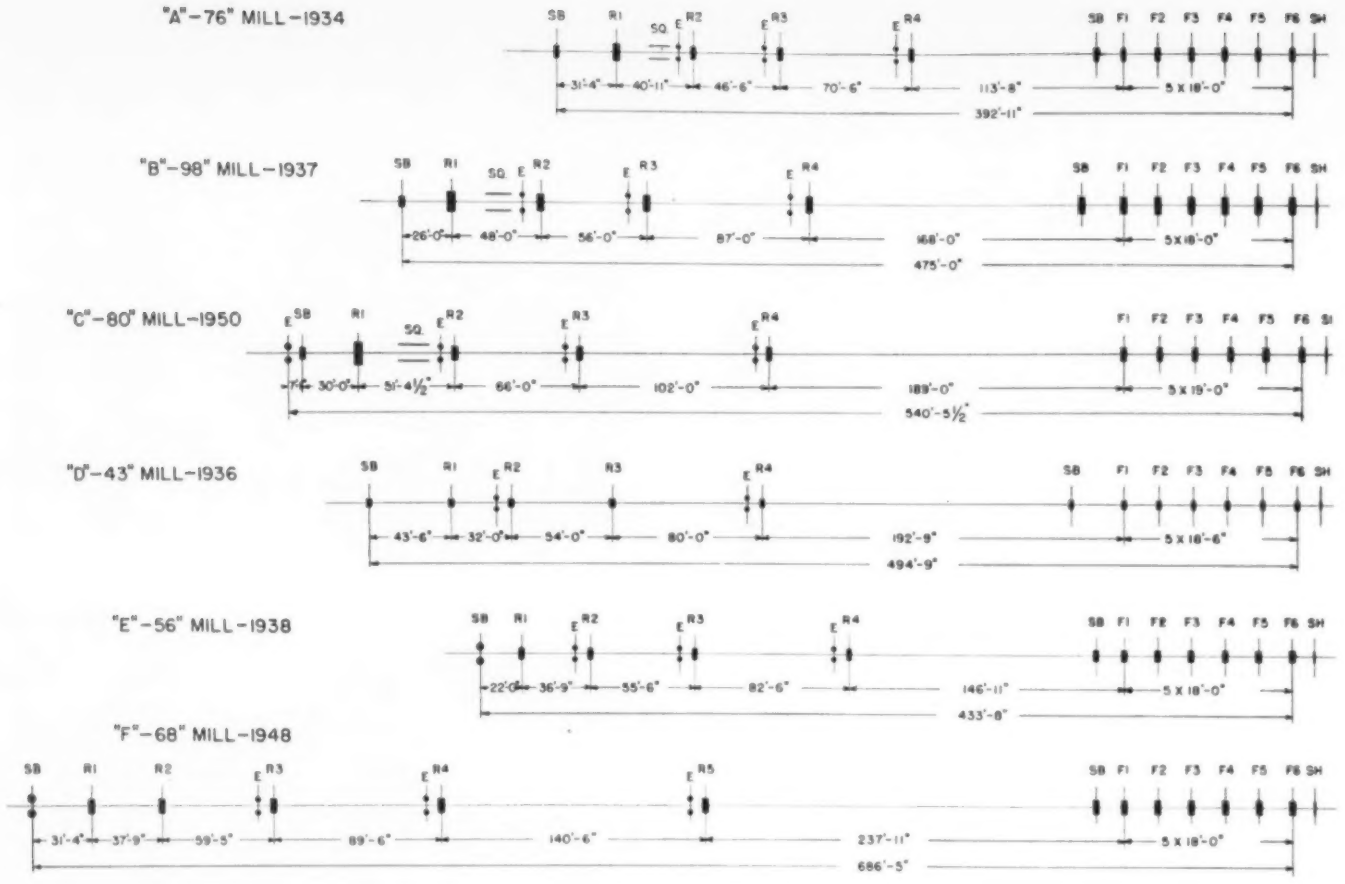


Figure 5 — Drawing shows comparative arrangement of representative continuous hot strip mills.

motor on R-4 is operated with short circuited secondary.

Plan "C" is for an 80-in. mill now under construction for installation in France, and shows still further increase in roughing stand spacing and total overall length to 540 ft-4½ in. The broadside stand R-1 has 130-in. long rolls to enable spreading long slabs. The spreading pass is of only short duration, and the peak load quite high, so stand R-1 has flywheels and is driven by a 3500-hp induction motor with slip regulator secondary control. Stands R-2, R-3, and R-4 are geared for speeds of 224, 315, and 430 fpm, respectively, and each of these three stands is driven by a 4500-hp synchronous motor. Figure 6 shows the 2500-hp induction motor driving stand R-1, and 4000-hp, 5000-hp and 4000-hp synchronous motors driving stands R-2, R-3, and R-4, respectively, of the 80-in. mill of the Armco Steel Corp., Middletown, Ohio.

Plans "D" and "E" are for 43 and 56-in. mills, respectively. On the 43-in. mill, each of the four roughing stands is driven by a 2500-hp induction motor, however, no flywheel is provided on any of the roughing stands. On the 56-in. mill, each of the roughing stands is driven by a 3000-hp synchronous motor. The first roughing stand R-1 is two-high and is driven by a 144-rpm motor. Stands R-2, R-3, and R-4 are four-

Figure 6 — Roughing stand drives for 80-in. continuous hot strip mill.

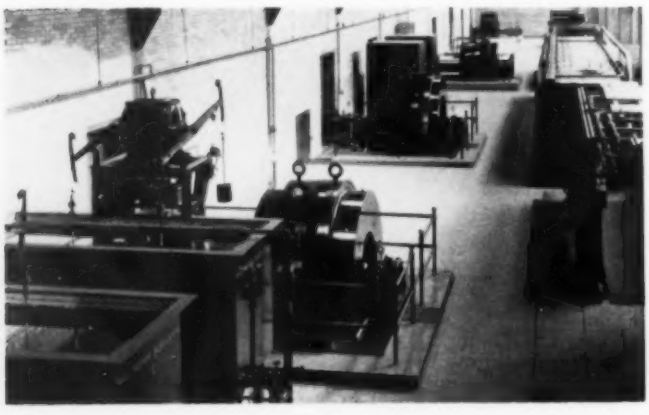
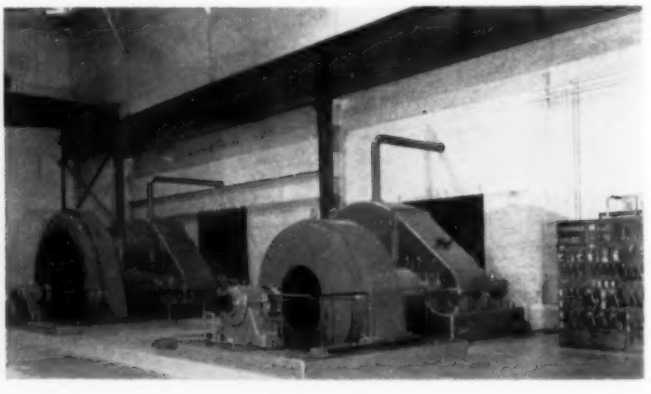


Figure 7 — Illustration shows two 3000-hp, 144-rpm synchronous motors which drive the first two roughing stands of a 56-in. continuous hot strip mill.



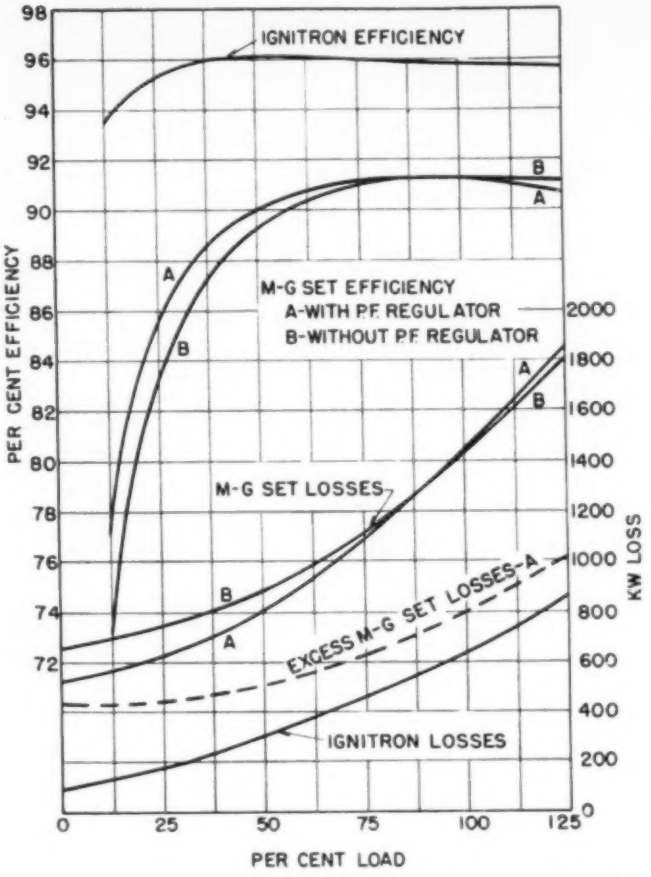


Figure 8 — The curves compare efficiencies of a 15,000-kw, 700-v ignitron rectifier with a 90 per cent power factor motor-generator set.

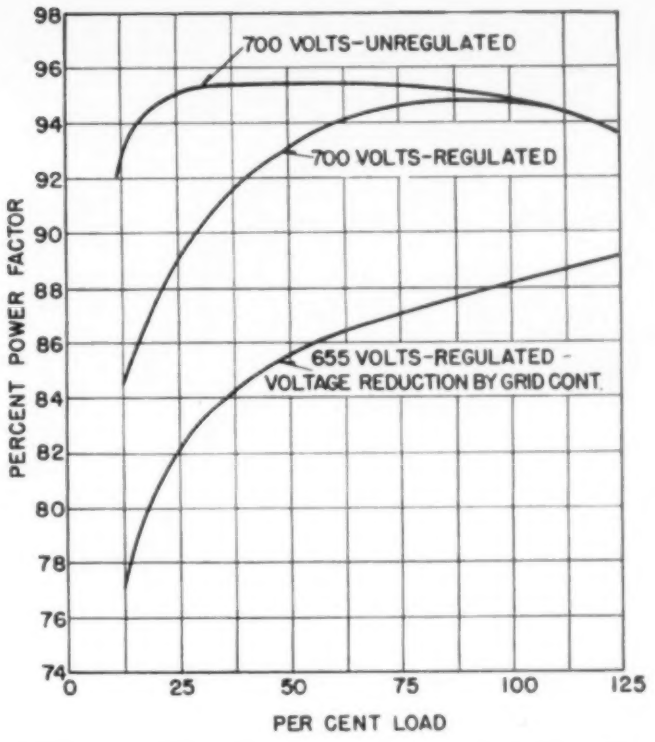


Figure 9 — Curves give power factor of 15,000-kw, 700-v ignitron rectifier under several voltage conditions.

high, and the motor speed is 360 rpm. The R-1 and R-2 stand motors are shown in Figure 7.

Plan "F" at the bottom of Figure 5 shows a modern 68-in. wide mill. The plant slabbing mills provide slabs up to 62 in. wide so that even the widest strip is rolled straight-away, without turning and spreading. The roughing stand spacings are quite large, also the layout is unusual in that there are five roughing stands to enable rolling from extremely thick slabs. The vertical edging scale breaker and each of the five roughing stands are driven by synchronous motors, of 800 hp, 2000 hp, 3500 hp, 4500 hp, 4500 hp, and 4500 hp, respectively. The mill is stated to be capable of rolling 6½ in. thick by 22 ft-0 in. long slabs, up to maximum weight of 27,600 lb.

TABLE I

MERCURY ARC RECTIFIERS FOR STEEL MILL MAIN ROLL DRIVE SERVICE

No.	Year installed	Units	Total kw	Application	Mfg	Location
1*	1942	1—3000	3,000	10-in. Hot strip mill	U. S.	U. S.
2	1943	1—2500	2,500	Merchant mill	U. S.	U. S.
3*	1945	2—3500	7,000	66-in. Hot strip mill	U. S.	U. S.
4	1949	2—5000	10,000	Hot strip mill	U. S.	U. S.
5	1949	1—1500	1,500	Seamless tube mill	U. S.	U. S.
6	1949	1—3500	3,500	Seamless tube mill	U. S.	U. S.
7	1950	3—5000	15,000	66-in. Hot strip mill	U. S.	France
8*	1950	3—5000	15,000	56-in. Hot strip mill	U. S.	Austria
9	1951	3—6000	18,000	80-in. Hot strip mill	U. S.	France
10*	1950	1—4000	4,000	79-in. Hot strip mill	U. S.	U. S.
11	1951	2—5000	10,000	54-in. Hot strip mill	U. S.	U. S.
12	1940	6—2400	14,400	Hot Strip mill	German	Germany
13	1950	30—700	21,000	Hot strip mill	English	Wales
		Total	124,900			

*Rectifiers on items 1, 3, 8, 10 operate in parallel with motor generator sets. On the other items rectifiers provide the entire finishing mill main drive d-c power supply.

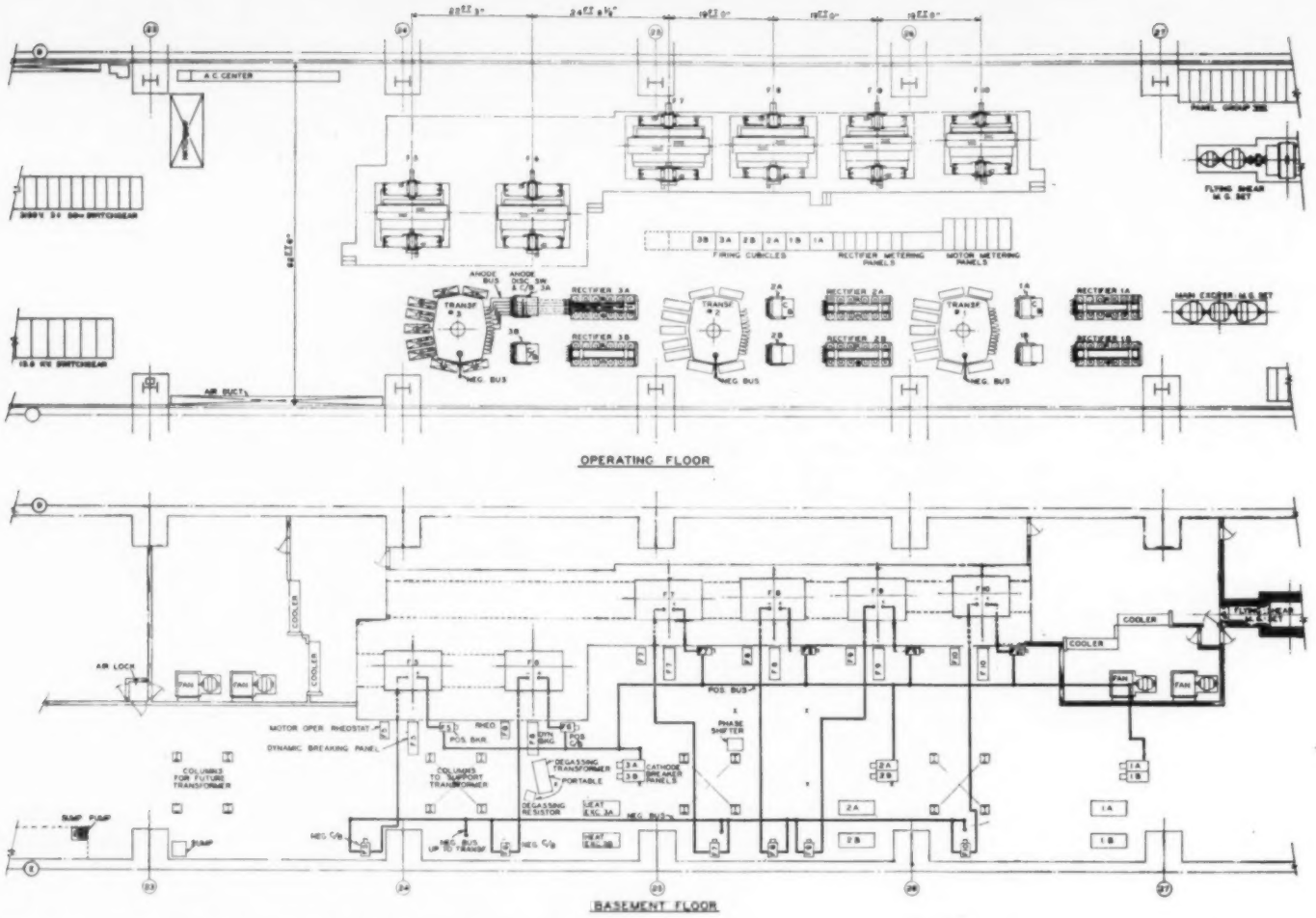


Figure 10 — Drawing shows layout of operating floor and basement flooring plan of 80-in. hot strip mill motor room using ignitron rectifiers for finishing mill power supply.

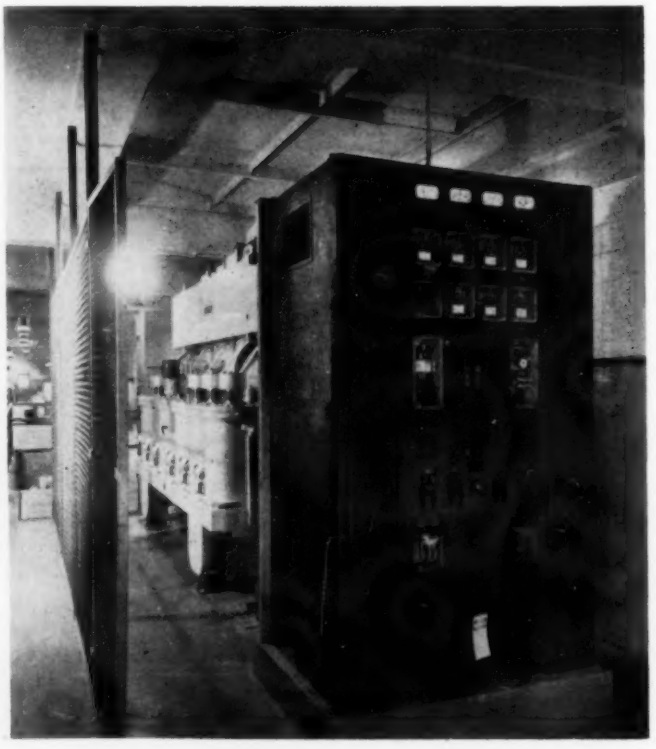
Synchronous motors have advantages of lower first cost, higher operating efficiency, ability to regulate power factor, larger air gap, etc., and hence are desirable wherever the load conditions permit their use.

IGNITRON RECTIFIERS FOR FINISHING STAND DIRECT CURRENT POWER SUPPLY

The finishing train of a continuous hot strip mill usually consists of six stands—occasionally only four or five and in one case seven—compactly arranged on 18 to 20-ft centers. The elongated strip will be in all of the finishing stands simultaneously for periods of 15 to 40 seconds or even longer, therefore, the stand speeds must be individually adjustable in order that the speeds may be controlled to avoid pulling or excessive looping of the strip between stands. The requirements of easy and accurate speed adjustment, good speed regulation, overload capacity, etc., are most satisfactorily met by compensated direct current motors, and this type of drive has been almost universally adopted. Individual motor ratings range from 2500 to 5000 hp, and the six finishing stand motors total from 15,000 hp on a narrow 42-in. mill to as much as 28,000 hp on an 80-in. mill now under construction.

The conversion from the three phase alternating current primary power supply to the 600 to 750 volt

Figure 11 — This 2500-kw, 600-v ignitron rectifier and firing control cubicle supplies power for a semi-continuous merchant bar mill.



direct current required for the finishing stand motors usually has been accomplished by synchronous motor-generator sets. However, during the last ten years, ignitron mercury arc rectifiers have become well developed, and under some conditions have advantageous features which make their use attractive for the power supply to the direct current main drive motors of hot strip and other rolling mills. Table I lists thirteen installations of mercury arc rectifiers totalling nearly 125,000 kw for rolling mill main drive power supply. Items 1, 2, 7, 8, 9, and 10 are installations of our equipment, and the remaining items are installations of other manufacturer's equipment of which we have knowledge. The seven items 4, 7, 8, 9, 11, 12, and 13 are large installations where the rectifiers provide the entire direct current power supply to hot strip mill finishing stand motors, and where the motors are started by phase control of the rectifier voltage. In Item 3, two 3500-kw rectifiers operate in parallel with three 3000-kw motor-generator sets, and in Item 10 a 4000-kw rectifier operating from 13,800 volts, 60 cycles will be paralleled with 14,000 kw of motor-generator sets operating from 6600 volts, 25 cycles. In these two installations, the rectifiers are connected to the bus only after the motors have been brought up to speed by generator voltage control, and the rectifiers are controlled to divide load with the motor-generator sets.*

For hot strip mill main drive power supply service, ignitron rectifiers and synchronous motor-generator sets may be compared as follows:

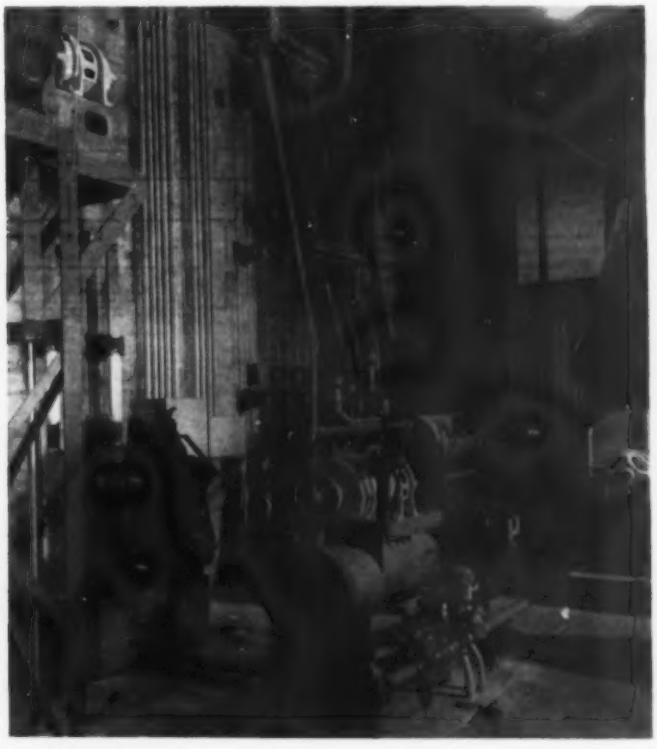
1. In unit capacities of 5000-6000 kw at 600-750 volts d-c, the first cost of a rectifier equipment will be quite appreciably less than the cost of a motor-generator set installation. On a recent job involving 10,000-kw of conversion equipment, the proposition including rectifiers was about $100,000 lower in price than an alternate proposition with motor-generator sets.
2. Experience with a large number of electrochemical, railway, and industrial installations, indicates that the maintenance expense for rectifiers will be only about two-thirds of that for motor-generator sets.
3. As shown in Figure 8 the efficiency of the rectifier is much higher than the motor-generator set, particularly at light loads. On the basis of a 15,000-kw installation, the rectifier losses at no-load will be 425 kw less than the motor-generator set losses and at 125 per cent load will be more than 1000 kw less than the motor-generator set losses. With usual load cycles the rectifier losses will average perhaps 600 kw lower, and the annual saving based on 5000 hours operation will be 3,000,000 kwhr.
4. An ignitron rectifier always operates at lagging power factor and the power factor cannot be controlled, whereas a synchronous motor-generator set normally operates at leading power factor, and

* Two additional installations of ignitron rectifiers for hot strip finishing mill main drive power supply have been made since this paper was presented. For one project, a 5000-kw 600-volt ignitron rectifier is being installed to operate in parallel with four 4000-kw motor-generator sets to provide the increased power supply capacity required by the changing of three of the finishing stand motors from 3000-hp to 4500-hp.

The other project is a completely new 80-in. hot strip mill, where the six finishing stand motors totalling 29,000 hp will be supplied from six 4000-kw, 700-v rectifiers. All of the motors and rectifiers may be operated together on a solid bus, or the bus may be split into two or three sections operating at different voltages, obtained by taps on the rectifier power transformers.

Figure 12 — Power transformer for 2500-kw ignitron rectifier is located in basement under rectifier.

Figure 13 — The rectifier heat exchanger d-c circuit breaker and anode circuit breaker are also located in the basement below the 2500-kw rectifier.



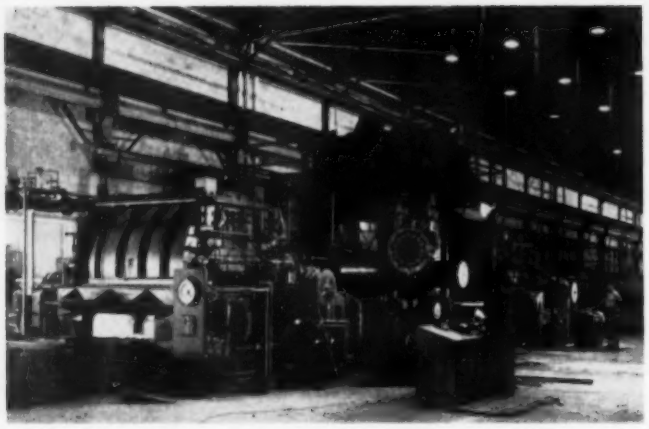


Figure 14 — This 54-in., 4-high reversing hot strip finishing mill is located in a Kentucky plant.

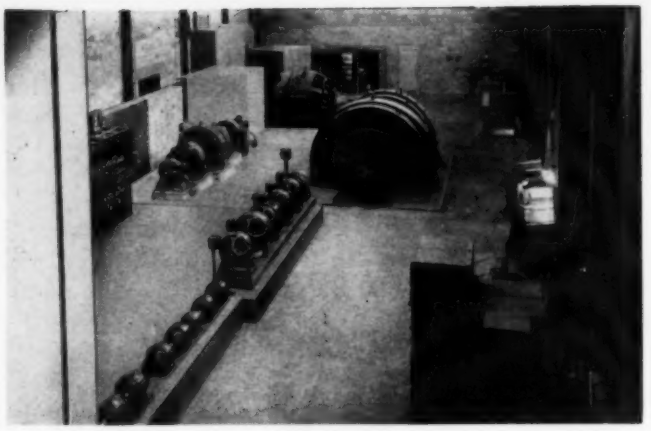
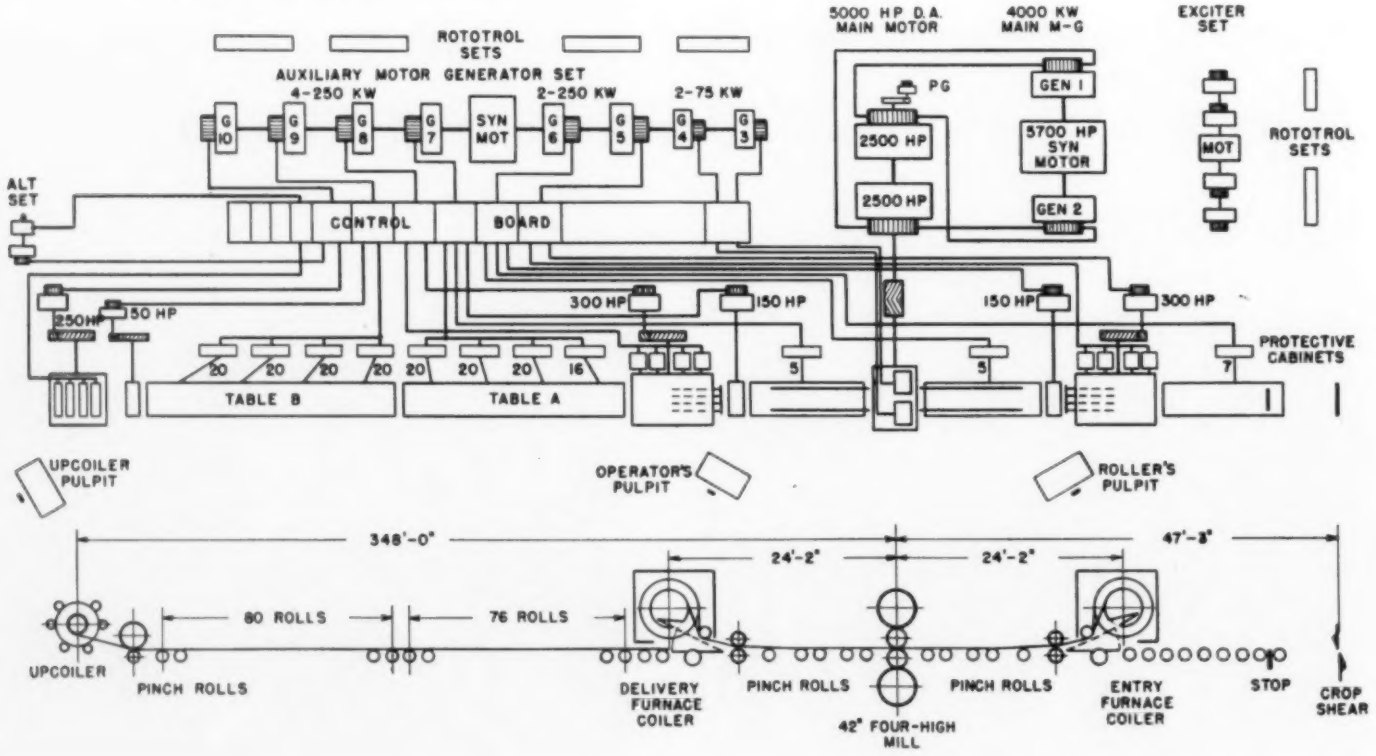


Figure 15 — Motor room for 54-in. reversing hot strip finishing mill shown in Figure 14.

the power factor and reactive kva may be regulated to minimize voltage variations. However, if synchronous motors are used for the roughing stand drives, auxiliary motor-generator sets, air compressors, etc., the overall power factor usually can be maintained not far from unity. Figure 9 shows the power factor of a rectifier under different conditions. Operating unregulated, the rectifier would have a power factor above 95 per cent for most of the load range, as shown by the top curve. However, with regulation by phase control to maintain flat bus voltage, as is necessary on a hot strip mill drive, the power factor at light loads is considerably reduced, as shown by the middle curve. The bottom curve shows the still lower power factor when the voltage is regulated to less than normal value.

5. As indicated above, the rectifier power factor is quite low when the voltage is reduced by phase control, however, it is practicable to use phase control and bring the mill motors up to speed much the same as with a motor-generator set installation. However, it is not satisfactory to operate under load with the voltage reduced by phase control, and reduced voltage taps must be provided on the rectifier transformer if the mill is to be operated at less than normal voltage.
6. With rectifiers for power supply, the mill cannot be stopped by regenerative braking as the rectifiers will not transmit reverse power. Thus dynamic braking must be employed to obtain quick stopping.
7. The installation of rectifiers usually is much simpler than of motor-generator sets. Because of the

Figure 16 — Drawing shows pass line arrangement and schematic electrical connections for 42-in. reversing, hot strip finishing mill.



absence of heavy rotating parts, elaborate foundations are unnecessary and it is only necessary to provide support for the static weight of the transformers. Because of the high efficiency and direct water cooling of the rectifier tubes, the ventilation system is of much smaller capacity.

Figure 10 shows the operating floor and basement floor plans for part of the motor room for an 80-in. hot strip mill now being erected in France. The first two finishing stands F-5 and F-6 are driven through reduction gearing by 4500 hp, 125/282 rpm motors. The motors for the remaining four stands are direct coupled, the motors for F-7, F-8 and F-9 each being of 5000 hp and for F-10 4000 hp, making a total finishing mill motor capacity of 28,000 hp. Power for the finishing mill motors is supplied by three 6000-kw ignitron rectifier equipments. The rectifiers, anode breakers, and rectifier power transformers, are installed at the operating floor elevation, and the rectifier heat exchangers, cathode breakers, and motor breakers, rheostats, and dynamic braking panels are installed in the basement. Each of the rectifier transformers weighs about 170,000 lb, and is supported on four steel columns. Aside from these supporting columns, the basement area is open and much less crowded than would be the case with motor-generator sets requiring massive foundations. The rectifiers operate from the 13,500-v, 50-cycle primary power supply, and the d-c voltage is 700.

Figure 11 shows the installation of a 2500-kw, 600-v, ignitron rectifier and its firing control cubicle, installed in a West coast plant to supply power for several motors driving a semi-continuous merchant bar mill. Figure 12 shows the rectifier power transformer which is installed in the basement below the rectifier, and Figure 13 shows the rectifier heat exchanger and d-c circuit breakers, also installed in the basement. The anode breaker, connected in the circuit between the transformer and rectifier, is partly visible behind the heat exchanger. This installation was made in 1943, and incorporates features of adjustable voltage starting of the motors by rectifier phase control, regulation to maintain flat bus voltage, and transformer taps to enable normal operation at 450 and 525 volts as well as at rated 600 volts. Thus except for its smaller capacity, it is representative of the equipment required for a large strip mill.

REVERSING TYPE HOT STRIP FINISHING MILLS

The highly developed continuous hot strip mill has well demonstrated its capacity to economically produce extremely large tonnages of high quality strip. There is no question but that the large proportion of hot strip will continue to be produced in such large continuous mills.

However, for the smaller plants having limited capital to invest, and requiring only a moderate tonnage output, the reversing type hot strip finishing mill is advantageous. Four such mills have been installed in plants in the United States within the last year, and American manufacturers have supplied equipment for at least two foreign mills, one in Europe and one in South America.

In some installations, the strip mill consists of only a single reversing stand, and reheated slabs 3 to 5 in. thick are reduced to strip by being passed back and forth through the mill. During the first few passes, the bar is run out flat on the tables, and after it has been reduced to ½-¾ in. thick it is directed up into furnace coilers and thus coiled and kept hot between passes. However, two recently installed mills are arranged to roll strip directly from ingots, and consist of two separate reversing mills. The first mill is essentially a conventional universal slabbing mill, and in it the ingots are rolled down to plate or bar, usually ¾ to 1¼ in. thick. After cropping the front and rear ends, the bar goes directly to the second mill, which is of heavy construction and four-high roll arrangement, and in about five or seven passes is reduced to finished hot strip gages (0.060 to 0.150 in. thick). The bar may be run out flat on the table after the first finishing mill pass, but even after the first pass and after each succeeding pass except the last, the strip is directed up into one or the other of the two furnace coilers. During the last pass the strip is run out over the runout table and coiled in a conventional hot strip coiler.

Figure 14 is a view of a 54-in. four-high reversing

Figure 17 — It is reported that this 42-in. reversing hot strip finishing mill is giving very economical production.

Figure 18 — Motor room for 42-in. reversing hot strip finishing mill.

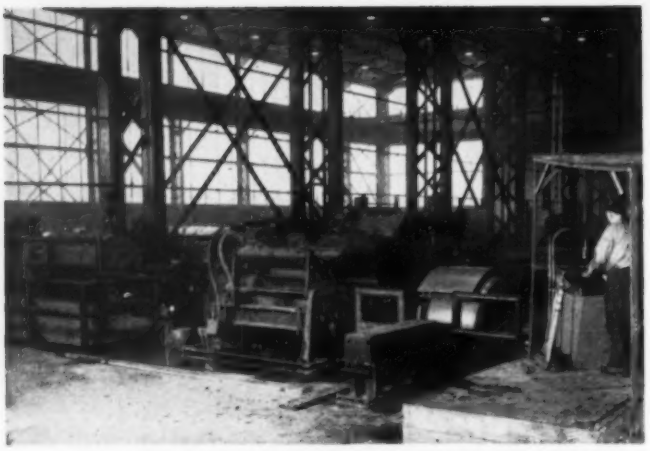


Figure 19 — The upcoiler is located about 350 ft from the 42-in. reversing hot mill.

hot strip finishing mill, installed in a Kentucky plant. The view shows the two furnace coilers, located above the entry and delivery tables about twenty feet from the mill. The two operator's master control benchboards are located on the mill floor opposite the furnace coilers. This mill is capable of rolling strip up to about 50 in. wide, and can operate at speeds up to 1250 fpm maximum. Figure 15 is a view of the motor room. In the background is the 4000-hp, 700-v, 100/200-rpm main drive motor which is coupled direct to the pinions and mill working rolls. Power for the main motor is supplied by the 3500-kw synchronous motor-generator set. At the left is a portion of the control board, and the auxiliary motor-generator set for variable voltage operation of the furnace coilers, guide rolls, mill and runout tables, and finished strip upcoiler.

Figure 16 shows the schematic arrangement of a 42-in. reversing hot strip finishing mill which has just been placed in operation at a Detroit district plant. At the bottom of the figure is the schematic pass line arrangement of the mill showing the relative location of the four-high mill stand, furnace coilers, pinch rolls, crop shear, runout table, and finished strip upcoiler. The upper part of the figure shows the schematic arrangement of the main roll and auxiliary electrical drive equipment.

The main working rolls of the mill are driven by a 5000-hp, 125/312.5 rpm, double armature reversing motor which is supplied from a three-unit motor-generator set consisting of two 2000-kw generators and a 5700-hp synchronous motor. The double armature construction of the 5000-hp main motor was necessary because of the relatively high speed and wide speed range. The nine-unit auxiliary motor-generator set consists of a 1250-hp synchronous driving motor, two 75-kw generators for the screwdown, and six 250-kw generators for the other auxiliary drives. One 250-kw generator No. 5 supplies the 300-hp entry furnace coiler motor and four 3-hp table roll and deflector roll motors, and the 250-kw generator No. 6 supplies the 150-hp entry pinch rolls motor and twelve approach table and entry table roll motors. Generator No. 7 supplies the 150-hp delivery pinch rolls motor and five delivery table roll motors, and during the last pass also supplies the seventy-six motors driving the first section of the runout table. Generator No. 8 supplies the delivery furnace coiler and four roll motors. Generator No. 9 supplies the eighty 3-hp motors driving the second section of the runout table, and the 50-hp pinch rolls motor. The last of the 250-kw generators No. 10 supplies the 250-hp upcoiler motor and the blocking roll motor alternator set. The 250-kw auxiliary generators are controlled by rotating regulators to control the generator voltages in proportion to the main motor speed, and the two 300-hp furnace coiler motors and 250-hp upcoiler motor are controlled by rotating constant current regulators to maintain tension on the strip being wound or unwound.

Figure 17 is a view of this 42-in. mill, with a finished hot strip running out on the runout table under the delivery furnace coiler. The two master control benchboards, one opposite each furnace coiler, are raised about 24 in. above the mill floor to afford a better view of the strip.

Figure 18 is a view of the motor room. In the upper background are the 4000-kw main motor-generator set, and the 5000-hp double armature main reversing motor. In the foreground are the nine-unit auxiliary motor-generator set, and the twenty-five panel control board which provides the entire control of the main mill and all of the auxiliaries. The electrical equipment is ventilated by a downdraft air cooling and recirculating ventilation system.

Figure 19 shows a finished coil as it is pushed from the mandrel type upcoiler onto the coil conveyor. The upcoiler is located at the end of the runout table, about 350 ft from the mill.

This mill is designed for operation up to a maximum speed of 2000 rpm which is about 50 per cent faster than any other reversing type hot strip mill, and in the ten weeks since it was placed in regular operation early in December, 1949, has successfully operated at more than 1500 fpm. A complete ingot can be reduced to strip in one piece, and the mill regularly produces finished coils weighing 16,000-20,000 lb. Usual finished gages are 0.080 to 0.125 in., however strip as light as 16 gage has been rolled.

WANTED!

There is a constant demand for copies of "The Modern Strip Mill", published by the Association of Iron and Steel Engineers. If your copy is not in use please get in touch with us.

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Increasing Combustion Efficiency

IN THE STEEL INDUSTRY

By J. G. SPARKS
Engineering Department
Cities Service Oil Co.
Chicago, Ill.

. . . . by continuously analyzing oxygen, unburnt hydro-carbons and fuel gases as combustion occurs, efficient control can be applied to the combustion process . . . .

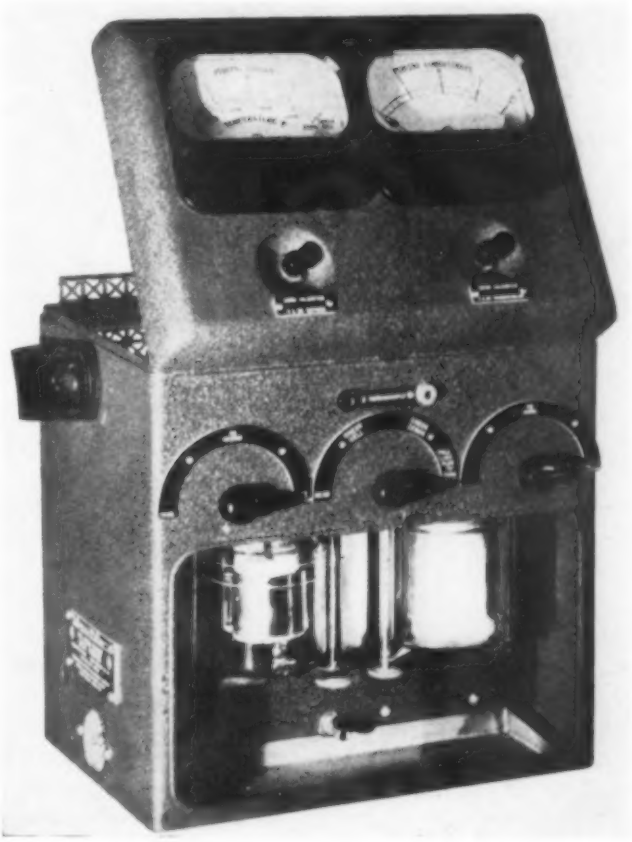
▲ THE development and application of instruments and control equipment has increased so materially in recent years that today few processes remain which do not benefit by instrumentation. While it is not always thought of as such, one of our basic raw materials in the steel industry is energy—energy in the form of heat. Because all but a small fraction of the energy we need comes from the combustion of fuels, the use of proper instruments is imperative.

Modern industry demands the highest possible efficiency in all of its processes, and the combustion step is not exempted. The days are gone when a pyrometer temperature measurement and a squint at the color and character of the flame constitutes "combustion control." Greater accuracy, quantitative instrumental control and the elimination, as nearly as is possible, of potential human error are demanded.

The heat prover (Figure 1) has a definite place in the steel industry's need for instrumentation. It is of value to two of the cardinal items given for efficient open hearth operation. These two items—furnace and personnel — represent approximately a 70 per cent value to that operation. With some modification, these same values will apply to furnace operations other than open hearth.

The heat prover is designed to measure combustion efficiency of any type of furnace using any form of fuel. It measures both the percentages of oxygen and the unburned hydrocarbons in the fuel gases. These products of combustion are measured both accurately and continuously, and the readings are both instantaneous and continuous. With this information you have the percentages of oxygen, combustibles, excess air and CO_2 present in the gases. Inasmuch as heat prover readings are direct, and not inferential, it is not necessary to assume that certain conditions exist—you can

Figure 1 — The heat prover measures the waste caused by air deficiency or dilution.



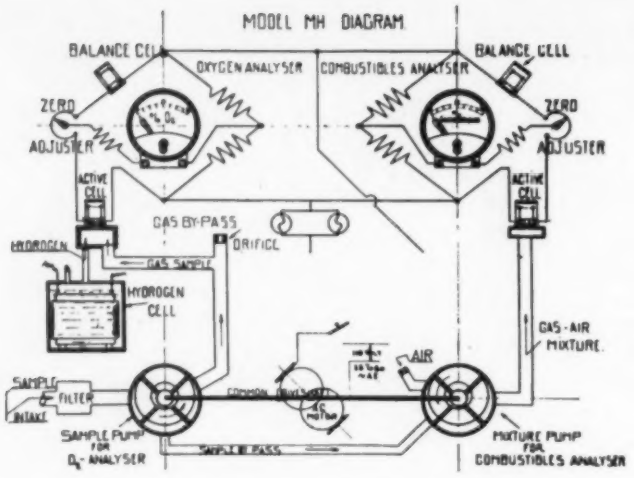


Figure 2 — Schematic diagram of industrial heat prover.

accept conditions as they exist on the unit being tested.

A brief discussion on the instrument itself (Figure 2) might be of interest at this point. The heat prover is a portable instrument, complete within itself, weighing about 25 lb. Although it operates as a single unit it is convenient to consider it in two parts. One side is designed to measure combustibles, or unburned fuel, which is the product of incomplete combustion. This analyzer consists essentially of a catalytically active, electrically heated platinum alloy wire which forms one arm of a wheatstone bridge. Through a small governor controlled pump a continuous sample of gas is drawn into the instrument. A portion of this gas is mixed with air and passed over the hot leg in the combustible analyzer. If the sample contains unburned gases which are the result of incomplete combustion, they will burn on the surface of the hot wire and the resultant increase in temperature is registered on the meter, calibrated directly in per cent of combustibles.

The other section of the instrument is used to measure the oxygen content of the sample. In addition to a duplicate of the combustible analyzer, it has a self contained hydrogen generator. Here, a portion of the sample drawn in by the rotary pump is mixed with the hydrogen, passed over the platinum wire where it is burned with any oxygen present, and the increase in temperature is registered on the meter, calibrated directly in per cent of oxygen. For added convenience, the lower portion of the oxygen scale is arranged to indicate the stack or exhaust gas temperature in degrees F.

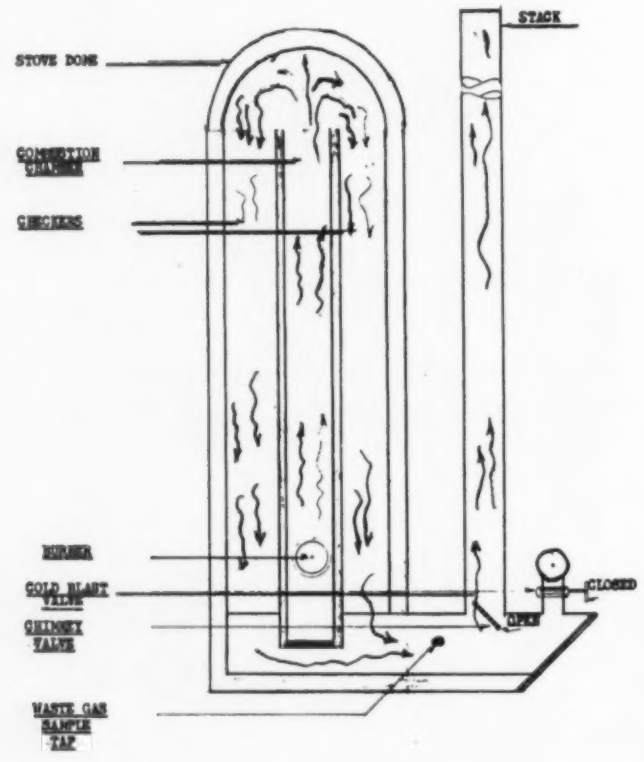
The constant speed motor driven pump, hydrogen generator, analyzers, all form an integral part of the heat prover, and all operations are automatic. Absolute accuracy is insured through the use of a unique system of checking instruments. In a test that takes about two minutes, laboratory analyzed gas of a known composition is fed into the instrument and corrective calibrations made if necessary.

This as well as other instruments are used to give you better product quality control, decrease down time, increase product volume yield and better effect economy of time, material and labor. The heat prover can be used to advantage on any type furnace, using any type fuel wherever you are interested in any of the above advantages.

The following will cover the need for the heat prover and some of its various applications in a steel plant, starting with the blast furnace area.

For a modern blast furnace, the blast volume is as high as 86,000 cfm. It is heated in regenerative hot blast stoves made of fire brick checker work incased in steel shells 20 to 25 ft in diameter and 80 to 100 ft high. In the constant search for lower costs and higher efficiencies, most steel plants are adopting stoves that will maintain maximum hot blast temperatures with a minimum gas consumption. To meet these requirements, stove capacity of approximately 7 square feet of heating surface and 1.8 cubic feet of brick volume is required per cubic foot of wind blown per minute.

Figure 3 — Sketch shows path of waste gases through a blast furnace stove.



The temperature of the hot blast has steadily increased since the days of the iron pipe stoves, with their maximum temperatures of 900 F, although there was a cutback in temperature during the experimental stages of using 100 per cent Mesabi ores. However, today blast temperatures of 1600 F are not uncommon, and even 1800 F has been used. Such temperatures are possible only through the use of very clean gas, pressure burners, and special checker brick. While there are a number of differently designed stoves used to furnish the blast, basically they all operate like the one shown in Figure 3.

The burner provides the gas-air mixture for combustion, the combustion takes place in the combustion chamber and the hot gases travel upward to the dome. Here the travel is reversed and the hot gases travel downward through a series of checker work where the heat from the gases is absorbed. The gases enter the flue through the chimney valve at temperatures from

250 to 300 F, then to the stack and into the atmosphere.

With variances in the Btu valve of blast furnace gas, and the increased temperature demands placed on the stoves, a definite and positive check of the waste gases must be made to properly set the fuel ratio control. By taking readings at this point the heat prover findings have been invaluable, and in this operation has been very favorably accepted.

From a combustion control standpoint, probably the most difficulty is experienced with the regenerative open hearth and soaking pit. On the open hearth, for example, the fuel engineer is confronted with several problems: it is a large and not too flexible unit, it is not a continuous process and, since physical punishment is of prime importance with personnel, has not always been chosen for technical background. For these reasons as well as others, one of the most practical applications of the heat prover is to determine and check the air requirements for open hearth furnaces. It is being used by many, both to determine air infiltration and to check fuel-air ratio controls.

Fuel-air ratio controls present a rather complex problem, especially when they are employed in multiple fuel firing. The measurement of viscous fuel oil is difficult, and when the engineer is confronted with varied sources of supply and/or methods of refining, the variations in physical characteristics of the fuel call for close observation and compensation for these changes. This necessitates corrections on the oil flow and air flow regulator, and, in multi-fuel firing, the gas regulator also.

One difficult problem is why fuel-air ratio controls do not give the desired or expected combustion results on large metallurgical furnaces.

On an open hearth which is single fuel, analysis of the waste gases will show considerable variation in excess air when the fuel input is varied over wide ranges. Checking at a time when the reactive gases given off from the bath are practically nil, variations in excess air may run from 15 to more than 60 per cent even though the fuel-air ratio control has apparently followed the fuel input. This wide variation is not necessarily the fault of the control, but may be due to furnaces that are poorly operated or maintained. This condition is caused by excessive air infiltration from one or more points in the furnace.

Regarding the use of infiltrated air for combustion purposes, it would seem that to set any fuel-air ratio control, it will be necessary only to allow for the predetermined amount of infiltrated air when making the calculations. It is important to point out that this setting will be correct for only one point of flow and, if correct at or near the maximum flow, a very high excess air value will be found at minimum flow.

While it is possible to control the O_2 value in waste gases to within a desired low range—say from 1 to 3 per cent on the downtake side—from maximum to minimum fuel input, apparently the high ratio of cold infiltrated air to preheated air at the low firing rates lowers the flame temperature to such a point that sufficient heat differential is not available.

In order to do an adequate job on open hearth furnaces, and maintain desired conditions, you not only need a fuel engineer but he must be supplied with the proper tools so that he might do the job. Today about 35 per cent of the furnaces are not equipped with force draft fans, hence no air measurement is possible. One of the most effective tools on a furnace is a good air flow meter. One leading steel manufacturer saved 5 per cent of their total fuel through the use of an air flow meter. This was accomplished by a graph chart showing air required, amount of air present due to infiltration, plus the amount furnished as primary air.

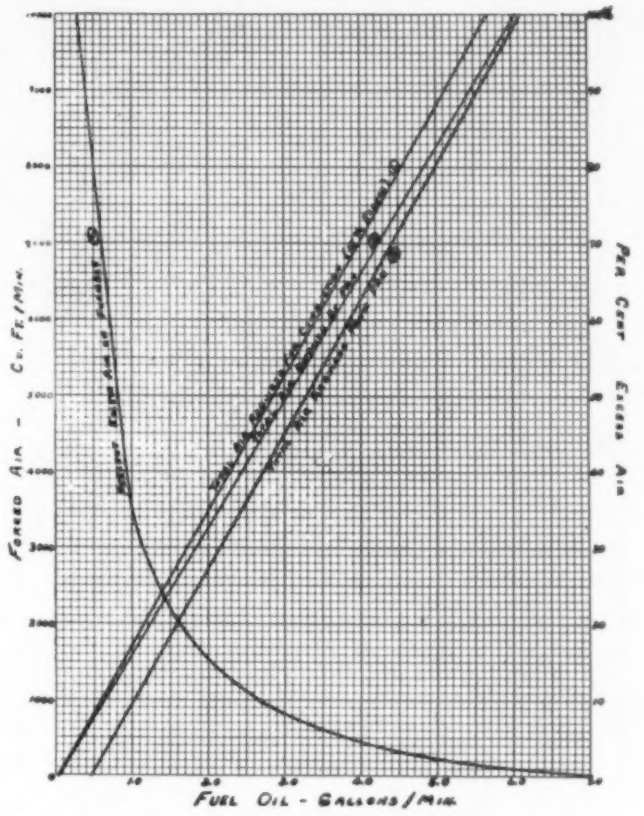


Figure 4 — Curve gives effect of excess air on fuel consumption. These curves which are based on open hearth furnace tests show that infiltration increases excess air markedly, particularly at low firing rates.

As you will note by Figure 4, the need for air flow metering is very definite. You can readily see how invaluable the heat prover can be in this type of work.

The importance of the heat prover in checking open hearth combustion becomes greater as the furnace grows older. We have increased air infiltration when

Figure 5 — Table gives desired furnace conditions for more efficient operation on the furnace.

Test on 225 Ton Furnace

A. Desired Furnace Conditions

Stage of Heat	Fuel	Steam Pres.	Air	Fce. Pressure
Melt Down (Chg. to Hot Metal)	350 Gph.	220#	600,000 cfh	.12 to .13 in. of water
Ore Boil	450 Gpr.	180#	450,000 cfh	.007 " .08 in. of water
Lime Boil	400 Gph.	140#	400,000 cfh	.09 " .10 in. of water
Refining	480 Gph.	160#	550,000 cfh	.11 " .12 in. of water

Fuel - Bunker C or No.6

Fuel Temp. - Average 195°F.

Fuel Vis. - Average 170 Sec. SU

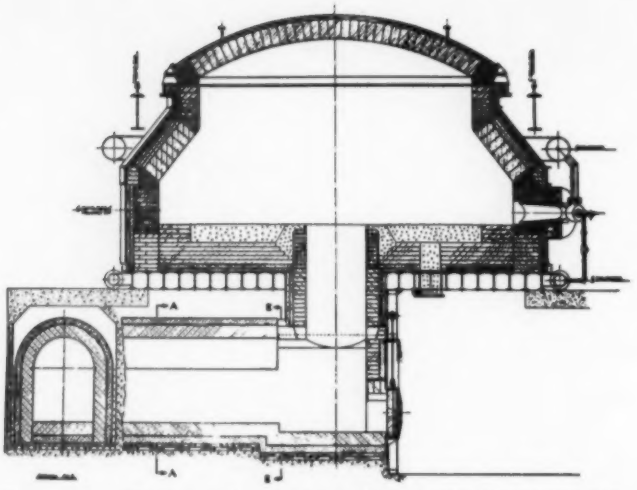
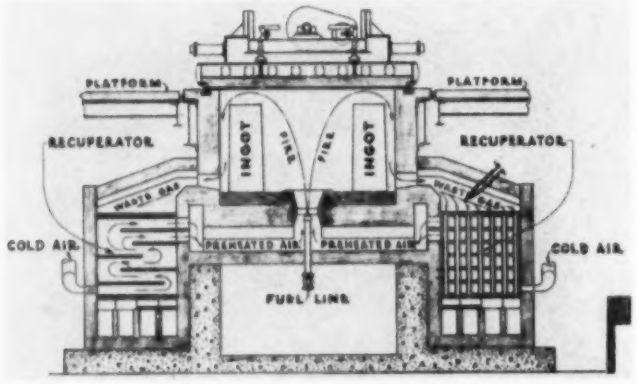


Figure 6 — The sample is taken at a point at the top of the roof, as near as possible over the burner.

Figure 7 — This square pit has a single burner located in the center of the hearth.



the furnace insulation starts wearing off and when the bricks themselves become loose and burnt and fall from place. We lose some degree of control when the checkers become dirty and clogged.

Tests run on several 225-ton open hearth furnaces (Figure 5) showed that during the average life of 250 to 300 heats they developed at least 35 per cent infiltration of air toward the end of the life. This represents an increase of 8 to 9 per cent of oxygen in the waste gases. If this infiltration is not taken into account it will result in longer time, from tap to tap and a higher ratio of fuel to tons produced. With periodic heat prover checks it is easy to regulate the controls to furnish the amount of air needed to give the furnace the proper atmosphere.

A viscosimeter was used to get the desired 170 second S. U., hence the temperature varied to get these conditions.

This particular furnace, for which the table was set up was fully automatic with reversal every fifteen minutes. It was also equipped with waste heat boilers. In starting the tests the schedule on Figure 5 was used.

From past experience we assumed this would give us desired flame temperature and furnace atmosphere. The samples were taken at the top of the checker downtakes at the end opposite the firing. We wanted to hold between 1½ and 3 per cent oxygen throughout all stages because we have found that when less than ½ per cent of oxygen is present we begin to show traces of combustibles, and if more than 1 per cent of CO is formed it will attack the silica in the furnace. If more than 3 per cent oxygen is present, it is an indication of too much air being used and the roof and the bath may be chilled. This calls for an increase in fuel consumption, and that is what we are trying to avoid.

The tests were started after ten heats had been tapped and the furnace properly broken in, yet this particular furnace, though properly insulated and in good condition, had air infiltration of from 8 to 10 per cent. This infiltration came from the burner ports, furnace doors and probably some from the dampers. It could have been lessened by increasing the furnace pressures but this would have shortened the life of the refractories in the front walls, roof and ends. With this amount of infiltration present from the beginning we had to calculate how much to cut back the controlled combustion air.

As the furnace grew older the infiltration increased to a peak of 45 per cent near the end of the furnace program. The source of this additional infiltration was brick work loosened by vibration, thin brickwork, broken brick and loss insulation. The combustion balance was further disturbed by dirty checkers and the formation of old men in the checker chambers.

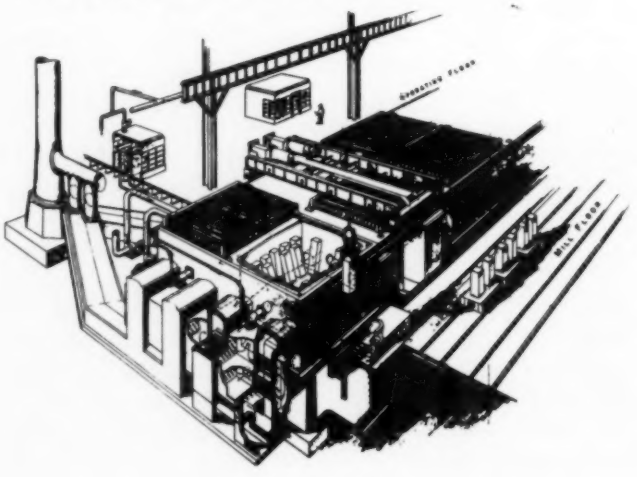
The heat prover has proven itself to be the major tool in control and use infiltrated air and the maintenance of a proper combustion balance.

SOAKING PITS

There are many types of soaking pits—round, square and rectangular. The round pit, Figure 6, many of which are in service throughout the industry, is made by the Salem Engineering Co. This type of pit has a series of tangential burners located in the lower third of the pit, set at angles to avoid impingement. It has but one waste gas port located in the center of the hearth, and is fully equipped with automatic control. The heat prover sample is obtained by inserting the sampling tip through the cover as nearly as is possible directly over the burner.

The Amco pit, made by the Amsler Morton Co. of Pittsburgh, is rectangular or square in design with a

Figure 8 — The pit illustrated is a rectangular recuperative type fired from both ends.



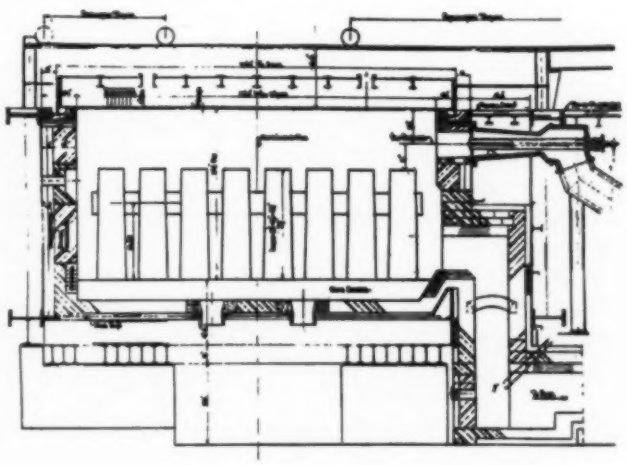
single burner located in the center of the hearth, (Figure 7), and is equipped with automatic controls. The waste gas ports are located on opposite walls in the lower third of the pit. There are two recuperators, one mounted on either side and the waste gases pass through the recuperators to a common flue and then to the stack. In the combustion pattern of this furnace the flame travels upward toward the cover and the hot gases are pulled down to the waste gas ports, then through the recuperators and to the stack. On this pit the heat prover sample is obtained by inserting the sampling tip into the first exhaust pass on the top of each recuperator. By checking here good fuel-air ratio can be maintained.

The Swindell pit is made by the Swindell-Dressler Corp. of Pittsburgh and is rectangular or square in design (Figure 8) and is equipped with automatic control. It is fired from the two ends, the flame being parallel to the hearth. The two flames meet in the middle of the pit directly opposite to each other and are forced to the top and sidewalls of the pit. They then travel along the back side of the ingots to the waste gas ports which are located in the four corners of the pit. The gases then travel directly through the recuperator and to the stack. On this pit the heat prover sample is obtained by inserting the sampling tip in each waste gas port. The knowledge obtained from these readings enables the fuel engineer to synchronize the burners.

The Surface Combustion pit is manufactured by the Surface Combustion Corp., Toledo, Ohio. It is rectangular in design. See Figure 9. It differs in its design from the reversing type in two major respects. It has continuous uninterrupted travel of flame and the air is preheated with recuperator, rather than with a regenerator. In this type pit fuel is admitted through one burner designed for proper heat distribution and efficient combustion. The burner is located in one end wall above the top of the ingots. The burned gases are exhausted through separate ports located in the same end wall under the burner and close to the bottom of the pit. This pit has automatic control. Combustion occurs above the ingots thereby preventing direct flame impingement which is very essential in production of steel. The hot products of combustion travel across the top of the ingots and double-back in a horseshoe pattern of varying lengths to the exhaust ports providing an even distribution of temperature throughout the pit and, therefore, to the ingots. The waste gas samples are taken at the top of the collector flue at the closest point of exhaust. The heat prover is very advantageous to this unit, so as to keep correct fuel air ratio.

Many steel plants have designed forms to record their pit conditions over a period of time and a complete history can be kept for reference to indicate when repairs or rebuilding are necessary.

Figure 9 — In this pit, combustion occurs above the ingot preventing direct flame impingement.



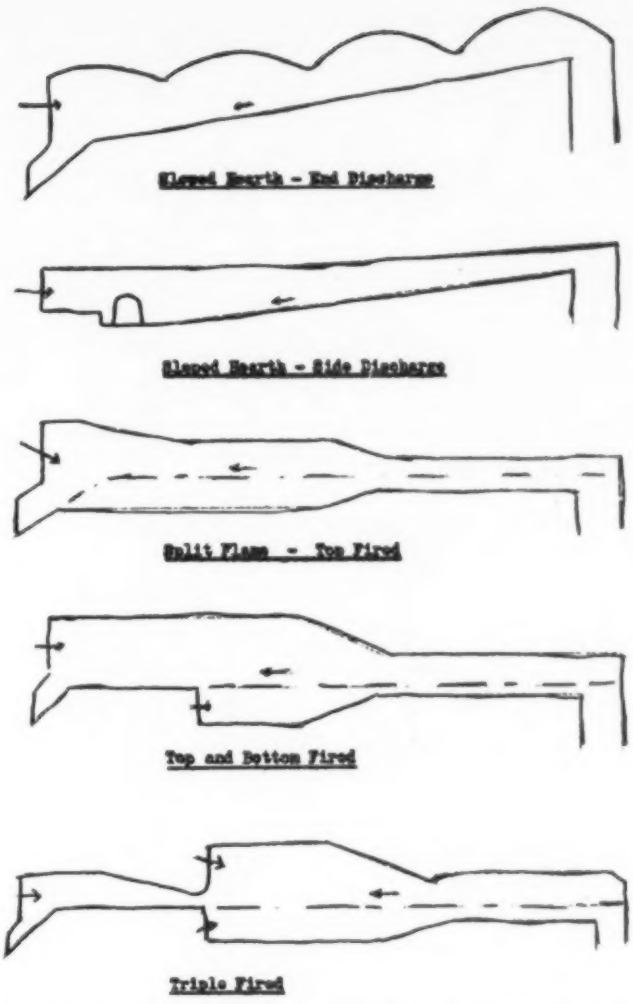


Figure 10 — Sketch shows a number of reheating furnace designs.

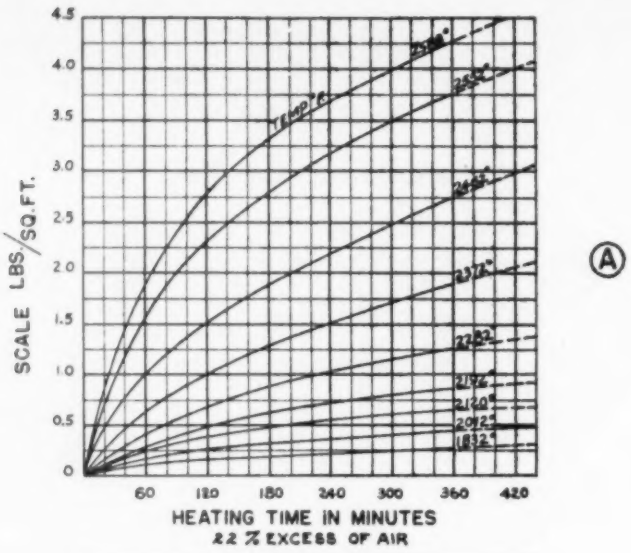
REHEATING FURNACES

Reheating furnaces are divided into two general classes.

1. Batch type.
2. Continuous type.

Batch furnaces are those in which the material to be heated is charged into the furnace and remains in a fixed position on the hearth until it has been heated to rolling temperature. Sample is taken, at the bridge wall before entering collector flue to the stack.

Continuous furnaces are those in which the charged



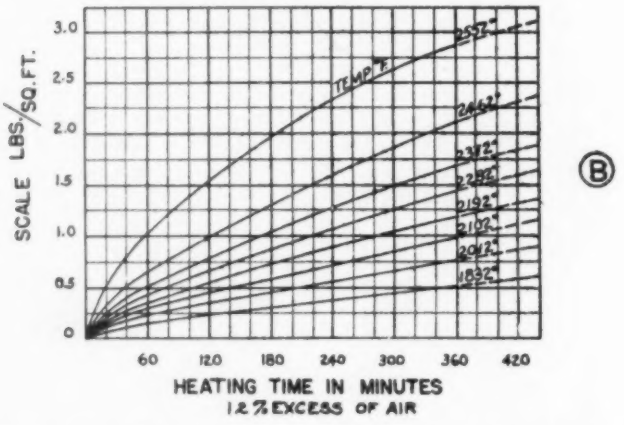
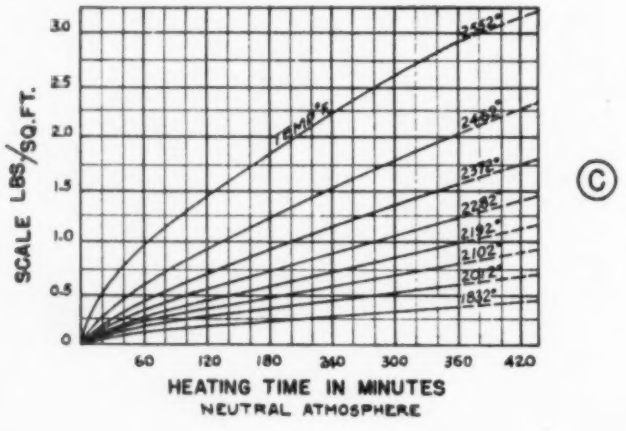
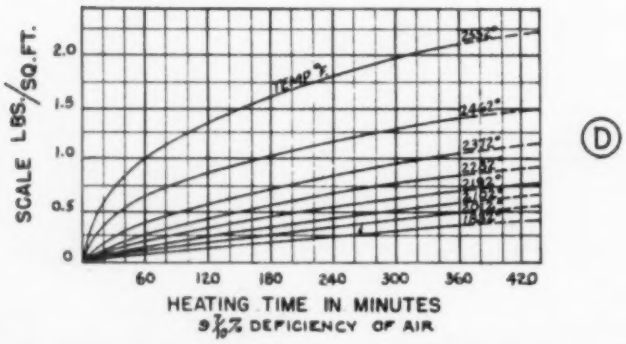


Figure 11 — Scale losses in a reheating furnace are very appreciable.

Figure 12 — Curve gives scale losses for neutral atmospheres and for 9.7 per cent deficiency in air.





material is heated to rolling temperature as it moves through the furnaces. Sample is taken—at the first pass before entering the flue to the stack.

There are many designs of reheating furnaces as indicated by Figure 10. We will not attempt to describe each of them. However, Figures 11 and 12 here is a graph showing scale losses, which I am sure will prove the need for heat prover combustion service where reheating furnaces are used.

We have shown you the application of the heat prover to the steel industry—we believe it to be the major tool for solving your combustion problems.

DISCUSSION

PRESENTED BY

A. H. ARBOGAST, Combustion Engineer, Combustion Department, Bethlehem Steel Co., Bethlehem, Pa.

J. G. SPARKS, Engineering Department, Cities Service Oil Co., Chicago, Ill.

A. WIGLAMA, General Supervisor, Steam and Fuel, Gary Works, United States Steel Co., Gary, Ind.

F. H. SPIESS, Fuel Engineer, Alan Wood Steel Co., Conshohocken, Pa.

GEORGE W. SAYER, Meters & Controls, Inc., Chicago, Ill.

C. D. HARTMAN, Mechanical Engineer, Bailey Meter Co., Pittsburgh, Pa.

A. H. Arbogast: Fundamental combustion data is the basis of economic fuel consumption and controlled metallurgical procedure regardless of type of furnace or process. We would have a difficult job keeping track of time without a clock, and anyone operating a furnace is paralleling this simile if he be without access to good gas analyzing instruments.

Twenty-five years ago I was initiated into the science of steel plant combustion, and my first tool of the trade was the portable orsat. The furnaces tested during that early period included the entire steel plate category, i.e., open hearths, soaking pits, blast furnace stoves, forging furnaces, treatment furnaces, and boilers.

Through these many years of combustion control experience many types of instruments have passed in parade. Carbon dioxide analyzers, both chemical and electric and combustible analyzers of various types, including the heat prover and oxygen analyzers, all of which are recommended for either snap tests or continuous sampling.

The ideal method of analysis is one which will produce a continuous indication or record. Continuous sampling for periodic or intermittent analysis is a cumbersome and complex procedure, and is possible and warranted only during periods of organized testing on a new or questionable furnace.

The big problem in continuous sampling is not in the

analyzing instrument but in the sampling tube. The maintenance of water cooled sampling tubes in open hearth furnaces or any other furnaces at temperatures over 2000 F is a nuisance of the highest order, and ranks only with the trouble encountered in trying to maintain continuous sampling through a porous filter, accompanied by subsequent cooling of the sample.

Our introduction to the heat prover came about 12 years ago, and our first application was on blast furnace stoves, and blast furnace gas fired blowing engines. Later it was applied to open hearths and heating furnaces. The heat prover is an excellent instrument.

Flue gasses comprise a combination of four gases which can be precisely determined: carbon dioxide, carbon monoxide, hydrogen and oxygen. In maintaining combustion control, at least two of these components are required by analysis for the purpose of guiding process control, i.e., either carbon dioxide and oxygen or carbon monoxide and oxygen.

With the portable orsat an analysis including CO_2 CO and O_2 can be completed in 15-20 minutes, depending on the skill and speed of the technician, although many samples can be taken over this same period of analysis time, if necessary, and analyzed at leisure.

If properly installed, and given sufficient time for temperature balance and adjustment, the heat prover will indicate continuously percentage of combustibles ($CO + H_2$) and O_2. However, we do not agree on the complete versatility of this instrument as indicated by Mr. Sparks.

The heat prover is excellent for use on soaking pits and heating furnaces where temperatures range between 2000 and 2300 F, and where water cooled sampling tubes are not necessary. However, in open hearth work our practice indicates that the interval between banking doors and adding hot metal is the best time for sampling. This period, ranging between 15 and 30 minutes, does not allow sufficient time for the proper balancing of the instrument before taking readings, and, because of the required proximity of the analyzer location to the point of sampling, surrounding temperatures will influence the instrument reading.

In our plant, at the present time, we are operating twenty portable orsat analyzers, several single tube analyzers for oxygen and three heat provers. Fresh, newly serviced chemical analyzers are available at the combustion laboratory at any time without notice, while the heat provers require the attention of special service engineers when single field service is inadequate.

Availability of this instrument, together with repair and replacement parts on the basis of direct sale or lease would go far to extend heat prover usage and make it more competitive with conventional analyzers. The current policy of availability and distribution permits only limited access to the service of this instrument.

This policy of instrument distribution, which includes the service of trained engineers and factory reconditioning, is probably the best method of servicing small plants with limited technical and instruments repair personnel. However, it is a definite handicap to a large plant where multiple applications require the uninterrupted usage of all machines and instruments.

The proper functioning of the heat prover is only possible when material and personnel are available for prompt replacement or repair in case of failure.

J. G. Sparks: Little did we expect that we would have to disclose what we have done on such a small scale. However, about now, we have the continuous heavy-duty heat prover. One of those is installed in one of the leading steel plants in the mid-west. This instrument is equipped with a recorder.

We had ten of these instruments in the cement industry that have an operating time of eighteen months, with one recorder, in constant operation, twenty-four hours a day, seven days a week.

The initial idea of this instrument, possibly, was never to operate such as is required of an instrument in the steel mills, as was ably set out. We believe that the success of this instrument is prompted by the way the instrument is built and that is, possibly, the reason for the scarcity of the instruments. Each of these instruments is built in our laboratory at Hillside, N. J., by hand. Sometime before my time with the company, they tried mass producing this instrument, and when they did, the accuracy and good operation suffered, and the ultimate result was not good.

To further this along, in regard to checking this instrument, we supplied many of the users of this instrument, test balances and regulators to enable them to check their own instrument in the plants.

I would like to know if you have any of these test bulbs and any of the test equipment? If you do not, we can expedite that, so that you can check the instrument much quicker.

As the demand is for the heavy-duty instrument, I am reasonably sure that we are going to supply you people that want them, as fast as we can.

The thought in mind is that we want to make them by hand and not have a mass produced instrument, because, I think, we are one of the few people that have an instrument that is not made on a production line basis.

A. Wiglama: The heat prover is a very useful tool for the combustion engineer. It has two distinct advantages over the manual operation of an orsat. First, the automatic and continuous determination of combustion conditions makes it possible for the combustion engineer to accomplish much more useful work in a given length of time. Second, the continuous operation of the heat prover permits the combustion engineer to follow changes in conditions as they occur.

There is a definite advantage in the use of the heat prover compared to the CO_2 indication as applied to the measurement of combustion of mixed fuels. A determination of O_2 and combustible with the heat prover would be an immediate guide to control of air flow while a CO_2 determination alone would have to be interpreted by a calculation involving the chemical analysis of the fuel mixture.

On a soaking pit, the waste gas sample is taken between the exhaust ports and the recuperator. An effort is made to adjust the fuel air ratio control to get ½ per cent oxygen at that point.

Until recently on an open hearth furnace the waste gas sample was taken in the neck arch between the downtake and checker chamber. At this point 2 per

cent oxygen was considered good practice. We are now taking the waste gas sample in the downtake just above floor level, and aiming for 0 to ½ per cent oxygen at that point.

Some difficulty has been experienced with the heat prover when attempting to operate it continuously for several days at a time in conjunction with a recorder. Water from the waste gas sample completely fills the catch jar provided, and spills over into the heat prover pump, causing a shutdown and damage to the instrument. Also, as all of you familiar with continuous gas sampling are aware, the sampling tube tends to plug up.

We feel a word of caution is in order. The heat prover is a very valuable tool in the hands of a good combustion engineer, however, you must remember that setting the correct fuel-air ratio does not solve all your combustion problems. You must still carefully study and correct items such as faulty burned design or maintenance, poor furnace design, and improper functioning of temperature and draft controls.

F. H. Spiess: The author has given us a very comprehensive report on this instrument and the efficiencies to be gained by its use. One feature of this equipment I would like to have more information on, and that is the sampling tube. We have found that steel pipe will give correct results only up to a certain temperature, then a nickel pipe can be used up to about 2100 F; then, of course, ceramic or water cooled tubes must be used on higher temperatures.

I would like to know if the author can give us more information on the sampling methods, particularly on eliminating the water cooled sampling tube.

J. G. Sparks: Considerable experimentation has been done by our laboratories on this problem. We have been able to overcome water cooling on soaking pits, and on reheating and annealing furnace, by the use of inconel and refractory sampling tips, also, at the present time we are experimenting with jet engine linings trying to perfect a tube for open hearth use, but have not been too successful up to this time.

George W. Sayer: Our company embarked on an electronic development program about four years ago. Of course, the major problem was the development of the electronic analyzer itself. After the development and acceptance by the industry of the electronic analyzer, many sampling problems came to light. After all, no matter what type of an analyzer or how good an analyzer you have, it is of little value if you cannot get the sample to it.

To give you an idea of how important sampling is, for the last three years we have employed several engineers to do nothing but work on sampling systems.

We have come across a number of very interesting and involved sampling applications. One of these problems was in high temperature measurement of the open hearth flue gas analysis. To my knowledge, no one to date has been able to use anything but a water cooled sampling tube on the open hearth. We have been successful by using a water cooled sampling tube inserted approximately four feet into the downcomer slightly below the plane of the burner. We use high velocity; in fact our sampling tube is 1¼ in. in diameter, moving gas at a velocity of approximately 35 fps through 1¼ in. pipe. I am thinking of one specific application in the east where we are developing the sampling system for this application. This instrument has been in operation for more than one year. The sampling line requires blowback with air once each week in order to keep it clean. Some installations will probably require blowback every day, depending on the operating practice in the particular mill.

One of the problems that has come up in sampling (and I do not believe many organizations realize it) is the effect of condensation in the sample line. The gas should be kept above its dew point. This is very important and many sampling systems on furnaces today have failed because of the sample moisture condensing out and continually causing plugging. The temperature drops very rapidly in the gas because of its low specific heat. When the temperature reaches its dew point or lower sulphur vapors and water vapors condense out causing an acid action and that is the start of your trouble.

In lower temperature installations such as boilers, refinery heaters, etc., we have used different types of material for sampling. Stainless steel, iron pipe, different types of plastic pipe and glass have been used in different applications with success. The most satisfactory installations are glass.

Recently one of the larger power companies in Northern Indiana went to an all stainless steel welded construction sampling tube. For about ten years they used glass with rubber connectors, but because of leakage in recent years with these connectors, they changed to the stainless construction. They have had several stainless welded lines in for about 2½ years and have had most satisfactory results.

However, it has been our experience that stainless steel as well as black iron and other type pipes can be eaten out with sulphur bearing condensation. The general use of stainless steel is definitely not recommended because in over half of the boiler installations, it will be corroded. In some instances, it is not better than black iron. These conditions cannot be predicted since the effects are based on unpredictable chemical conditions.

We have had successful installations of black iron pipe where the sulphur and water vapor are condensed out previous to entering the black iron pipe, or where the pipe is insulated. We have found that an inhibitor of scale formation will be built up in a black iron pipe, and no further corrosion will take place if kept above the dew point of the gas being drawn through the pipe.

Many sampling problems have been answered, but there are many still to be answered. Unless a representative sample can be brought to the instrument, the instrument is of little value.

C. D. Hartman: We are also interested in this problem of gas sampling on open hearths at high temperatures. We have a sampling system that works. We will go on record, of putting a sampling tube on an open hearth, having it remain open for as long as three months at a time in continuous service. We do that by taking enormous samples, about two per cent of which we use. It is a water-cooled sampling tube, emitting a fine spray of water right ahead of the opening for the gas sampler. This washes the tube and with this high velocity, high volume of gas, it will remain open.

METAL DRAWING LUBRICANTS FOR WIRE, TUBING AND SHEET STEEL

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. . . . many factors must be considered in the selection of the proper lubricant for drawing . . . . developments are moving at a rapid rate in this field . . . .

▲ IN the last fifty years, steel has been transformed from a conglomerate mass of metal to a complex series of alloys with accurately predetermined compositions. Simultaneously, advances have been made in heat-treating processes, in cleaning-house practices, in tool and die design and in metal-working machines. At the same time, the lubricant manufacturer working in conjunction with the steel fabricator has kept pace with this endless chain of improvements. As a result, we live in an age where quality metal products are mass produced.

It is the purpose of this article to summarize the progress which has been made in metal-drawing lubrication and to present some practical suggestions on the selection and use of lubricants for the drawing of wire, tubing and sheet steel.

THEORETICAL DISCUSSION

The principal function of a metal-drawing lubricant is to reduce friction and prevent metal-to-metal contact, thus eliminating scratching or breaking of the material being drawn and minimizing wear on the tools.

Lubrication falls into two major classifications: fluid-film type and boundary type. Fluid-film type lubrication is customarily encountered in journal bearings in which the surfaces of the moving parts are completely covered with a fluid layer of lubricant. This fluid film serves to separate the surfaces and thus prevent undue wear. Such fluids obey hydrodynamic laws in which the fluid friction is directly proportional to the viscosity of the oil, the relative velocity and area of the bearing surfaces, and inversely proportional to the thickness of the oil film. In this type of lubrication(1)*, therefore, the viscosity of the lubricant is the important criterion.

Because of the extremely high pressures usually encountered in metal-forming operations, the fluid film is broken and the operation is carried out under conditions of boundary lubrication. Boundary lubrication follows the laws of dry friction, i.e., the friction is equal to the product of the pressure between the two surfaces and the coefficient of friction. The main purpose of the boundary lubricant is to lower this coefficient of friction and thereby lower the forces necessary to carry out the drawing operation. Samuel Spring(2) has written a series of articles giving an extensive explanation of boundary-type lubrication. He has shown that a good boundary lubricant must give protection from the formation of welds during the drawing operation. These welds between the die and the metal being drawn occur due to the irregularity of the surfaces involved and the high heat formed during the drawing operation. A good boundary lubricant is one which minimizes the tendency toward the formation of these welds. In general, boundary lubricants are materials which have a high

Figure 1 — The bank of wire drawing machines are effecting a 6-stage reduction using a dry soap powder lubricant.

* Numerals refer to Bibliography at end of article.

degree of affinity for the surface of the metal involved so that they are adsorbed thereon. It is this adsorbed layer of lubricant which acts as the weld preventive.

Fatty acid molecules, for example, because of their reactive carboxyl group (acid group) are adsorbed by the surface of the metal in an oriented layer which acts as a good boundary lubricant. In contrast, mineral oils which are chemically quite similar except that they have no such acidic group are not adsorbed by the metal surface and form relatively poor boundary lubricants.

WIRE-DRAWING LUBRICANTS

In the last twenty years with the introduction of carbide dies and perfection of high speed wire-drawing machines, superior wire-drawing lubricants have been devised.

With the trend toward higher speeds and special finishes, the wire-drawing industry has required increasing amounts of specially prepared wire-drawing compounds. These products have been developed by the technical personnel of lubricant manufacturers working in conjunction with the operating and engineering staffs of the wire-drawing industry. The use of special raw materials and carefully controlled processes have resulted in wire-drawing lubricants which have helped in extending die life, increasing drawing speeds and improving finishes.

In steel wire drawing, there are four different methods by which the wire may be drawn. Dry drawing is carried out using powered soap. Wet drawing includes those practices using aqueous soap solutions, emulsions, and non-aqueous fluid lubricants. Grease drawing uses petroleum-base greases and thick soap-base pastes. Recently a fourth method has been introduced experimentally and on a limited production basis. This method employs an aqueous mixture of components which simultaneously deposit both the lubricant and the carrier on the wire.

A carrier for the metal drawing lubricant, such as lime, is applied to the wire after cleaning. Recently lime substitutes and other carriers have been gaining in popularity. For special finishes and for wet-drawing, metallic coatings including copper, tin, and zinc are commonly used.

Figure 2 — The wire passing through the die box on the left containing powdered drawing lubricant, picks up a small amount prior to being drawn. During the reduction, the coating of carrier and lubricant on the surface reduces friction and prevents metal to metal contact and scratching.

DRY-WIRE-DRAWING LUBRICANTS

When wire passes through the powdered lubricant in the die box, a small amount of the soap adheres to the surface and is carried into the die with the wire. The heat and pressure of the drawing operation transform the lubricant and carrier into a plastic film which serves to reduce friction and minimize metal-to-metal contact, thereby preventing scratching and increasing die life.

1. *Discussion of physical and chemical characteristics*— The chemical composition of a particular lubricant does not entirely determine its efficiency for a specific application. For example, a lubricant with its components mechanically mixed will give different performance characteristics from one with the same components chemically reacted. Hence, variations in manufacture will produce different lubrication properties in compounds having the same chemical analysis.

Wire-drawing soaps may be placed in two classifications, sodium and metallic. Sodium soaps, which are water soluble, are prepared by the reaction of caustic soda with fats or fatty acids, sometimes in combination with fillers such as soda ash and sodium metasilicate.

Metallic soaps, which are insoluble in water, include the calcium, aluminum and zinc salts of various fatty acids. Calcium (or lime) soaps are the most popular metallic wire-drawing lubricants although aluminum, zinc and barium soaps are also used. These metallic soaps may be made from many different fats and fatty acids and may be compounded with other chemicals to produce finished products with numerous applications.

Excessive moisture in a lubricant may result in poor film strength and, in addition, may be a cause of high consumption of soap powder through "caking" or "balling up" in the die box. Modern drying equipment and present techniques of quality control have practically eliminated this source of difficulty.

Wire-drawing powders are often referred to as being "too rich" or "too lean." "Richness" is a term implying a lower melting or softening range. These solid lubricants in combination with the carrier on the wire do not have a sharp transition from the solid phase to the liquid phase, but rather go through a slow change from hard solids to plastic solids over a wide range in temperature. Therefore, when the richness is greater, the temperature range at which softening takes place is lower.

For purely illustrative purposes, extremes may be used to explain "richness." Tallow, with a melting point near room temperature, would form a thin liquid film under the usual wire-drawing conditions and offers little resistance to metal-to-metal contact. Lime, with a very high melting point, would retain its abrasive characteristics under the most severe wire drawing operation.

If the lubricant is "too rich," it may melt and "ball up" in the die box. The coating on the wire is softer and more plastic with a rich lubricant and a given carrier; therefore, if the lubricant is "too rich" the coating may work off until shiny wire and scratching take place. On

the other hand, if the wire-drawing powder is "too lean" or "too dry," failure may result because the coating is not plastic enough and offers little or no lubrication.

The richness of a wire-drawing powder is affected by many factors. In general, the higher the fat content, the richer the lubricant will act. The addition of high-melting-point chemicals tends to increase the temperature range at which softening takes place and, therefore, decreases richness. Wire-drawing powders are furnished with these chemicals, usually alkalies, fused into the product. The ability of the lubricant to withstand greater temperatures and pressures is imparted by this homogenizing process. The consumer may mechanically add small amounts of a chemical, such as lime, and obtain a leaner working mixture. However, for wide variations in richness, a mechanical mixture will not give the same operating results as a homogeneous mixture.

Richness is also affected by the type of fat or fatty acid used. The method of manufacture will also influence the richness. Factors involved include the choice of the reaction itself, the temperature and time of reaction, and selection of catalysts.

2. *Factors affecting the selection of a lubricant for dry drawing* — Usually, one of the first considerations in selecting a lubricant is the composition of the metal being drawn. For example, under identical drawing conditions, high-carbon wire produces more heat and is more difficult to draw than medium-carbon wire. If this were the only factor to be considered, a higher melting-point lubricant should be used for drawing the high-carbon wire.

For a given percentage of reduction, the heat of deformation is proportional to the square of the diameter of the wire. The radiating surface, on the other hand, increases at a rate directly proportional to the wire diameter. Consequently, the surface temperatures on the coarser sizes are usually greater. For this reason it is customary to use leaner lubricants when drawing coarse wire.

Machine design must be considered in selecting a lubricant. The cooling of the wire by water-cooled dies and water or air-cooled blocks varies with different machines. Here again the richness of the lubricant to be used is governed by the temperature at which the drafting takes place.

Drafting practice, including speeds and percentages of reduction, influences the choice of a lubricant. Heavy drafting and high speeds usually require higher-melting-point lubricants to compensate for increased wire temperature.

Die design has an effect on lubrication. As the entrance angle is increased, for example, the reduction is carried out over a smaller area with corresponding increases in pressure and temperature. Consequently the lubricant must be higher melting.

Surface conditions sometimes affect the choice of a lubricant. The carrier and lubricant adhere more readily to a slightly etched surface than to one which is smooth.

An important factor in determining the proper lubricant to be used is the type of carrier which is employed. The heavier the lime coating, the richer the lubricant should be for best lubrication. Metallic soaps are preferred for use with lime substitutes because of their higher melting-points and because they tend to adhere to the coated wire better than sodium-type lubricants.

When selecting a lubricant, consideration must be given to the type of finish which is to be produced and its effect on subsequent operations. For instance, for spring wire, it is generally desirable to use heavily-limed rod or wire. The wire-drawing powder should be just rich enough to give good lubrication without producing a gummy finish which would be detrimental to the subsequent spring-wire-forming operations.

The sodium soaps usually give a thinner finished coating than metallic soaps, and one which is more soluble in water. Consequently, sodium soaps are often used where subsequent operations demand a wire which is more readily cleaned. However, if a soluble lime-substitute and metallic soap combination is used, practically the same result can be obtained as with a sodium soap and lime-coated wire.

WET-WIRE-DRAWING LUBRICANTS

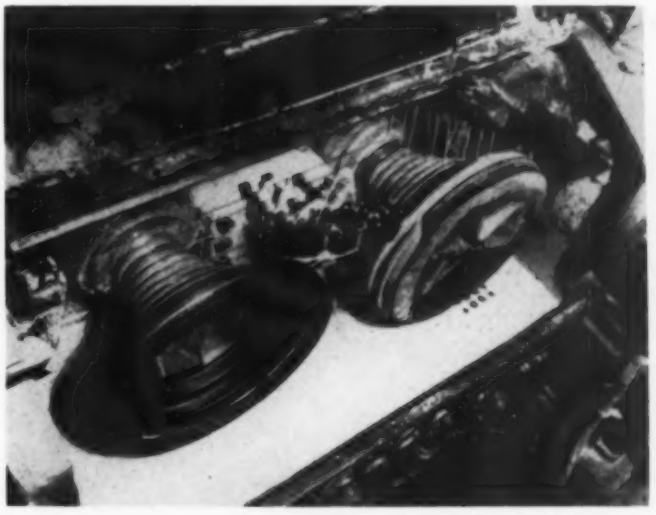
Wet-drawing lubricants fall into three classifications:

1. Straight-soap lubricants and modifications.
2. Emulsion-type lubricants and modifications.
3. Petroleum-oil lubricants and modifications.

Straight-soap lubricants are generally used for drawing the finer sizes of wire. Soap concentrations of one per cent by weight are usually sufficient. Contamination by acid and/or metallic salts frequently occurs from plating solutions, pickle residues, and lime. To counteract the effects of these impurities, various alkalies and sequestering agents are incorporated into the lubricant. These additives neutralize the acid and/or form soluble complex metallic salts, thereby extending the useful life of the lubricant.

Emulsion-type lubricants are made from fats or oils dispersed with soap or other emulsifiers. They offer more lubrication than the straight-soap type. However, they are not as stable to breakdown from acids and metallic salts because of the tendency for these ionic materials to destroy emulsions. The emulsion-type compounds are used at concentrations of approximately two to five per cent, and are well adapted for continuous drawing over a wide range of sizes. For galvanized steel wire,

Figure 3 — On this machine the wet lubricant is being recirculated.



neutral compounds are recommended to minimize attack upon the zinc.

Straight petroleum-base oils are not commonly used in wire drawing. They are improved through the addition of fats and fatty acids as well as certain sulphur and/or chlorine compounds. Such lubricants are used for drawing bar stock, fine stainless steel, and aluminum. A special mineral-oil-type emulsion with high resistance toward breakdown because of lime-salt formation is used for large rounds, hexes, and shapes.

WIRE-DRAWING-GREASE LUBRICANTS

This category includes the straight calcium-type grease lubricants. When used for continuous drawing, these lubricants are frequently mixed with lime.

Paste compounds which provide very little lubrication are used for drawing one-hole extra-bright wire. Greases are also furnished for drawing two- to five-hole wire for bright finishes. The wire produced with these special bright finishes is used for welding rod, coat-hanger wire, and other wire requiring an exceptionally clean surface; for example, that which is to be painted or electroplated.

CARRIER-LUBRICANT COMBINATIONS

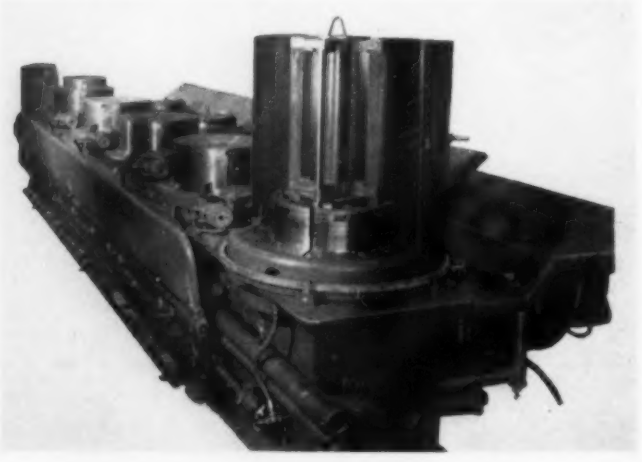
Several production tests on rod to be drawn twelve holes have been made with lubricant coatings put on in the cleaning house, thereby eliminating the die-box lubricant. Small quantities of wire have been drawn successfully in this manner. However, it appears that for more than a few holes, the use of a die-box lubricant is necessary to take care of mill variations. Nevertheless, this approach to the lubrication problem warrants continued research.

LIME SUBSTITUTES

There are two types of coatings used in place of lime: physically-bonded and chemically-bonded.

The physically-bonded type is usually made from various alkaline salts such as borax, soda ash and sodium metasilicate. Proprietary compounds are furnished with these chemicals as a base, plus small amounts of other chemicals; for example, wetting agents.

Figure 4 — The efficiency of wire drawing equipment is dependent on an adequate supply of the right die lubricant.



The second type is the chemically-bonded coating produced by a reaction between the surface of the metal to be drawn and the coating solution. Phosphate coatings, for example, have been used to some extent on high-carbon fine wire.

Physically-bonded coatings are being used more extensively than the chemically-bonded type. Although the initial cost of these carriers is higher than lime; this increase is usually more than offset by the over-all cost reductions. Among the advantages are a cleaner lime-free mill, elimination of baking, lower lubricant consumption, less tendency to rust, better die life, and cleaner finished wire.

There is some controversy concerning the relative merits of carriers. When lime substitutes are used, greater care must be taken to insure proper cleaning since lime tends to cover up poor cleaning. One manufacturer finds it advantageous to sull all rods and wire which are to be coated with borax. The effect of coating compounds on galvanizing, lead pick-up, and spring-wire finishes is also debatable.

Typical mill practice in the use of a lime substitute is well illustrated by the following instructions for the use of one of the proprietary coating compounds.

The coating solution should be used as hot as possible; at the boiling point, if practical. The rods or wire should be left in the solution long enough to bring the metal to the temperature of the bath. Three minutes are usually sufficient.

An average concentration of 12 to 14 ounces per gallon should be maintained. The concentration can be determined by chemical analysis as follows:

a. Pipette a 25 cc sample of the coating solution and dilute with 50 cc of freshly boiled distilled water.
b. Titrate with 0.9 normal acid to methyl orange end-point.
c. Each cc of acid used is equivalent to one ounce per gallon of the coating compound in the solution.

Baking is not necessary. Ordinary baking is undesirable, particularly, if temperatures exceed 400 F (204 C) over an extended period, but flash baking may be used. Air drying of rods and coarse wire is sufficient. However, some type of forced air drying is necessary for the finer sizes of wire because of their greater surface per unit weight and because trapping of the solution occurs.

The solution of coating compound is not corrosive, and it may be used in a steel or wooden tank. Closed steam coils should be used to prevent dilution of the coating-compound solution.

Acid drag-over from the pickling operation should be minimized by thorough rinsing or pressure washing since contamination weakens the bath.

With these coating compounds, it is preferable to employ metallic-type lubrications.

TUBE-DRAWING LUBRICANTS

Tube drawing poses many additional problems since both inside and outside surfaces must be considered.

In the early days of tube drawing, the accepted lubricant was a mixture of flour, water and tallow. When this combination was in proper working condition, it was an excellent lubricant. Its disadvantages included a tendency to go out of balance and turn rancid and

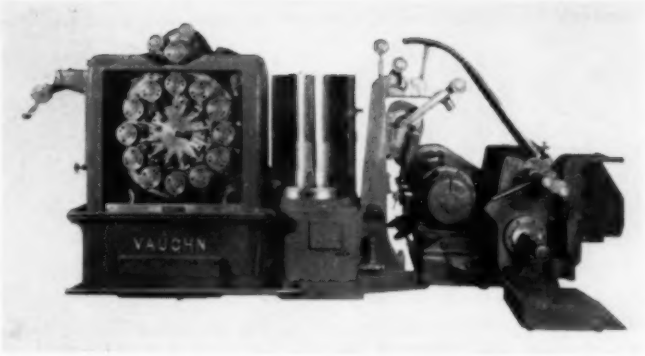


Figure 5 — Continuous machine for drawing of wire.

odoriferous. This method has been almost entirely discarded in favor of present day undercoatings and lubricants.

Another pioneer tube drawing lubricant was an emulsion-type compound composed of palm oil or other fat emulsified with soap. This type of lubricant used as a dip found increasing favor because of the improved finishes obtained with it, because it was easier to control, and because it did not have the other undesirable characteristics of the tallow and flour mixture. The emulsion-type lubricant has become the most popular in use today, as a result of the introduction of tungsten-carbide dies and mandrels and iron phosphate undercoating.

Petroleum oils, although fairly inexpensive, are not very good boundary lubricants. When fatty acids or fats are added to mineral oils, the film strength of the resultant lubricant is improved. Sulphur and chlorine compounds have also been added, but because of their corrosiveness, there is a limit to the amount of these materials which can be added without deleterious effects. The petroleum-type compounds have found limited use for tube drawing in the recirculating-type benches and for drawing over a bar.

Fillers are used in tube-drawing compounds in much the same way as they are used in wire-drawing soaps. Both water-soluble salts and insoluble pigments are used as fillers. The latter must be suspended by agitation or held in suspension by the viscosity of the solution. These fillers provide a non-combustible layer of material on the surface of the tube which acts as a cushion and helps to prevent metal-to-metal contact.

Waxes have also been added to tube-drawing lubricants, but these waxes have the disadvantage of being expensive. Furthermore, the same effect can be obtained through the use of a high-titer fat in the preparation of the emulsion. Consequently, at the present time, one of the most effective tube-drawing lubricant is the emulsion-type compound containing soap, high-titer fatty acids and fats, and, in some cases, fillers (water soluble salts and/or pigments). These compounds are furnished in paste form and are mixed with water to form the emulsion.

Undercoatings have played an important part in tube drawing. Before the introduction of phosphate coating, an oxide coat, similar to the sull coat of wire drawing, was often used to provide a porous surface which readily absorbed the metal-drawing lubricant. In addition, the iron oxide served as a cushion to aid lubrication in exactly the same manner as a filler in the lubricant. The advent of the phosphate coating represented a big step forward in tube-drawing technique. A homogeneous chemically-adherent absorbent phosphate coating of uniform thickness can be produced in about five minutes. The cost of this undercoating is more than offset by the greater percentage of reduction possible, by the increase in speed of drawing, by increased tool life, reduced scrap, and improvement in quality of tubing. At the present time, a somewhat analogous technique involving a ferrous oxalate treatment is being used to facilitate the drawing of stainless steel.

METHODS OF CONTROL FOR USE IN TUBE DRAWING

The most common causes of difficulty with tube-drawing lubricants are contamination of the bath, improper water content, and improper free fatty acid content. The difficulties from contamination have markedly decreased as cleaning house techniques have been improved.

Changes in the water content of the tube-drawing emulsion may occur as the result of water carry-over from the rinsing operation, water lost by evaporation, and water unwittingly added to counteract the effect of excessive free fatty acid as explained below.

Tube-drawing lubricants are generally used hot because the excess lubricant drains off more readily and the remaining lubricant is more easily dried. Dried tubes minimize handling problems for the draw-bench operator, and improve the effectiveness of the lubricant. Additions must be made periodically to replace water lost by evaporation.

The amount of free fatty acid in a tube-drawing emulsion is a critical quantity. One of the proprietary lubricants has an optimum operation range between 0.8 and 1.0 per cent free fatty acid. If the free fatty acid is allowed to fall below this range, there is a sacrifice in lubricity; values above the optimum range result in an increase in the viscosity of the tube-drawing lubricant resulting in excessive consumption and delays in drying.

Once the free fatty acid of a tube-drawing lubricant has been adjusted to the proper range, there are two factors which might result in a change; contamination and excessive temperature. Inasmuch as phosphatization takes place just prior to lubrication, acid contamination occurs most frequently. The double decomposition reaction which takes place between sodium stearate (soap) and phosphoric acid yields as its end products sodium phosphates (neutral salts) and stearic acid (free fatty acid). The result is an increase in the free fatty acid content of the lubricant.

If a lubricant tub is run too hot, the fatty material may decompose into neutral glycerine and free fatty acid. For this reason it is recommended that most lubricant tubs be operated in the 140 to 160 F range which gives adequate heat for drying the tubes and, at the same time, minimizes this source of free fatty acid.

As the free fatty acid content increases, the viscosity of the solution also increases and, although operation is possible at high concentrations of free fatty acid, the lubricant coating is too thick and the time for drying is increased. This increase in fatty acid may give the

impression of a high solids content similar to the effect noted when there is a loss of water by evaporation. Thus, it is possible for an inexperienced operator to add water to lower the viscosity instead of correcting by adjusting the free fatty acid concentration.

The free fatty acid is determined by titration of a sample of the emulsion dissolved in alcohol, using standard alcoholic potash solution and phenolphthalein indicator. The solids content may be determined by evaporating a weighed sample to dryness and weighing the residue, or by the xylol method.

The "T" test is an empirical control developed by one of the tubing manufacturers. A sample of the lubricant is drawn into a 100 cc pipette with a standard drainage time. The time required for the emulsion to drain from this pipette is an empirical measure of its usefulness as a tube-drawing lubricant. If the time required for drainage is too long, it is an indication that the free fatty acid must be adjusted or that the solids content is too high. Hence, for best results, it should be used in conjunction with the other control methods mentioned above.

SHEET-METAL-DRAWING LUBRICANTS

Aqueous sheet-metal lubricants include straight soaps and emulsions with all the variations mentioned for wet-wire-drawing and tube-drawing lubricants. Addition of pigments, like mica and talc, improve the effectiveness of aqueous lubricants.

The dried-film-type lubricant employs a soluble mixture of soap and salts; sometimes waxes and wetting agents are added. The parts are sprayed or dipped in an aqueous solution of the lubricant and then dried. This method is particularly applicable to mass production involving heavy drafts; for example, high-speed production of cartridge cases.

Non-aqueous lubricants include mineral oils, with or without fat or fatty acid additions, and modifications involving the use of pigments and extreme-pressure additives (sulphur and chlorine compounds, lead naphthenate).

The selection of a suitable sheet-metal-drawing lubricant is determined by the following:

1. The severity of the metal-forming operation, including the speed and depth of the draw, the reduction of wall thickness, and the gage of the metal being drawn.
2. Tool materials and design.
3. The type of metal being drawn; its metallurgical composition and its surface condition including the use of auxiliary coating.
4. The ease of subsequent removal by available cleaning methods.

A slight change in any of the factors affecting the performance of a particular metal-forming operation may considerably improve the operation, or it may cause failure. Lubrication is only one of these factors. The importance of proper lubrication, however, cannot be over-emphasized.

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DISCUSSION

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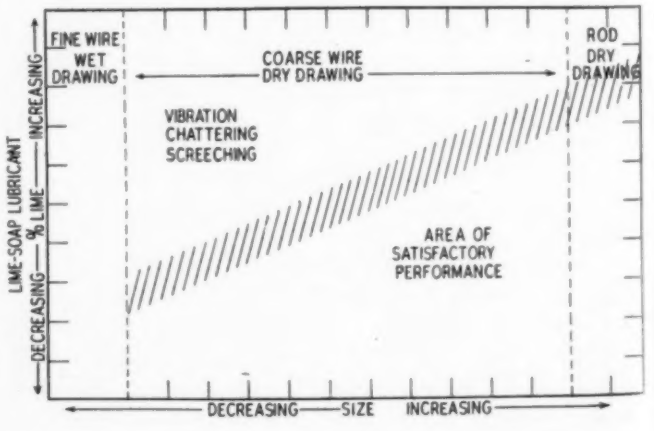
S. L. Stalson: General concepts and conclusions resulting from tests performed at our laboratory are in close agreement with the statements in this article which appear under the heading of "Dry Wire Drawing Lubricants." As far as we know, this is the first appearance in the technical literature of a discussion on regulating the plasticity of the lubricant to fit the drawing operation by adjusting the ratio of the low melting and the high melting ingredients in a dry lubricant. Because we have found this concept to be helpful in understanding past behaviors of dry lubricants and in anticipating their performance in new applications, we want to make a few comments on the subject even at the risk of repeating material already presented by the authors.

In the following remarks, we are limiting ourselves to dry lubricants composed of lime and soap mixtures, lime coated steel rods and wire, and the first draft of multiple drafting operations.

On the basis of general observations, it was concluded quite sometime ago, that the entire field of wire drawing with dry lubricants could be represented by a diagram such as the one shown on Figure 6. Since this diagram is based on general observations rather than actual

Figure 6 — Hypothetical relationship between drawing performance and lime-soap ratio.



test data and is speculative in some respects, it has been labeled "Hypothetical Relationship Between Drawing Performance and Lime-Soap Ratio." The horizontal co-ordinate represents the size of the rod or wire being drawn and starts at the left with the fine sizes which are usually drawn wet and extends to the rod sizes at the right. The vertical co-ordinate represents the lubricant composition and covers the range from zero lime content at the bottom to 100 per cent lime at the top. The dry drawing area of the diagram is then divided into two sections by a diagonal line. The region below this line represents lubricants and sizes that result in satisfactory drawing performances and the region above the line represents drawing practices that would be unsatisfactory if not completely inoperative.

This diagram illustrates the fact that while lubricants containing a high percentage of lime perform satisfactorily for the drawing of very coarse wire and rod sizes, they are nevertheless entirely unsuitable for dry drawing small wire sizes, and that for any size wire or rod there is a limiting lime content above which normal drawing operations are impossible.

Besides the lime content of the lubricant, there is the lime coating on the rods or wire that must be considered.

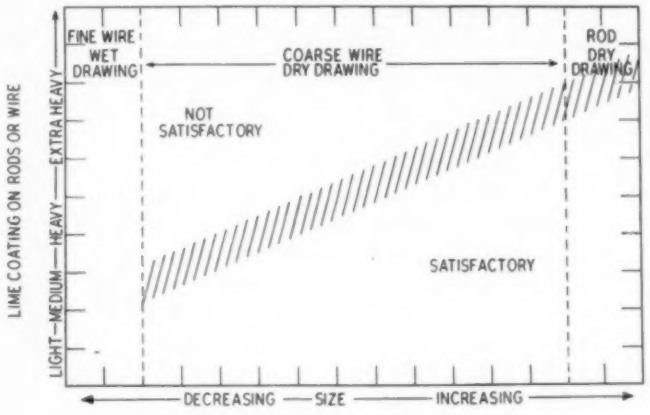


Figure 7 — Hypothetical relationship between lime-coatings and drawing performance.

The effect of the lime coating is represented by the diagram of Figure 7 which differs from the first one only in its vertical co-ordinate. To illustrate this diagram, assume an intermediate size wire with a medium lime coating is being drawn successfully with a given lubricant composed of lime and soap. Then suppose an extra heavy lime coating is put on a batch of this same wire and an attempt is made to draw it with the same lubricant. Now, however, the point representing the intermediate size wire and an extra heavy lime coating is in the area of unsatisfactory drawing performance, and it would be impossible to perform this operation.

The authors have already discussed the caking or balling that takes place in front of the die when using plain soaps or soap rich lubricants. However, we would like to add that caking is also a function of the size of the wire that is being drawn as shown on Figure 8. Caking is at a maximum when drawing large sizes with lubricants containing little or no lime. As the size decreases or as the lime content increases, the caking decreases and is entirely eliminated as the practice approaches the transition zone. Two vertical co-ordinates have been drawn on this diagram to indicate that this relationship exists regardless of whether you are dealing with variations in the lime soap ratio of the lubricant while using a constant weight of lime coating or with variations in the weights of lime coatings while using a given lime-soap lubricant mixture.

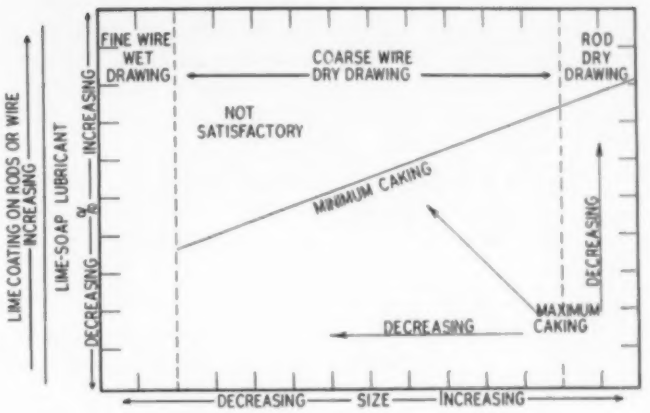


Figure 8 — Hypothetical relationship between caking and lime-soap ratio.

The location of this diagonal transition zone which separates the satisfactory and unsatisfactory practices is not entirely dependent on the lime-soap ratio. Some other factors in wire drawing practices which tend to raise this dividing line thereby permitting the use of more lime in the lubricant, heavier lime coatings, or both, are higher carbon steels, faster drawing speeds and heavier drafts. Conversely, the transition zone is lowered and less lime is indicated when practices are changed to lower carbon steels, slower drawing speeds or lighter drafts. These and several other factors such as die life, special finishes, machine characteristics, etc., can be represented by similar diagrams, however, the foregoing examples are sufficient to show the possibilities of this particular method of attacking the problems of wire drawing with dry lubricants.

Karl A. Arnold: Our experience at Ellwood City has indicated that the choice of a tube drawing lubricant results from compromising several important factors, some of which are surface finish of finished tube, size and wall thickness of finished tube, per cent reduction per pass, drawing speed, and surface condition of rolled tube.

After experimenting for quite a few years with many types and kinds of drawing lubricants, we have found that flour and tallow mixed with water and then dried on the tubes makes the best lubricant for drawing larger tubes where surface finish is not critical.

We concur with the authors of the paper that it is a difficult lubricant to control, however, with skilled personnel it can be kept in proper working condition. This point is very important, for without competent operators and mixers, it will go out of balance and become useless.

On smaller tubes, such as those in the range of two inches outside diameter and under, with light wall, we have found that the majority of drawing lubricants available today do a satisfactory job. On tubes such as these where surface finish is of prime importance, we found that a phosphate undercoating covered with an emulsified soap tallow mixture gives good results. This

lubricating set-up is applied hot and dries within a few minutes after the tubes have drained. Then it is permissible to draw. However if this lubricant is allowed to dry thoroughly for several hours or more, a much better surface is obtained.

E. L. H. Bastian: Without implying any serious disagreement with the authors' views, it is felt that several items in the paper are worthy of further discussion here.

The point of desirable homogeneity of dry soap type wire drawing lubricants is well taken. Other investigators (1)**find the best frictional properties are obtained when the soap film has a closely coherent texture, is uniformly deposited over the surface, and is firmly adsorbed. The use of a homogeneous lubricant helps toward such conditions, although of course, its ability to be adsorbed on the metal surface will depend upon other factors, principally the presence of polar compounds and/or chemically reactive constituents.

The authors' discussion of "rich" and "lean" lubricants as related to melting points of constituents in the coating is also of interest. Bowden (1) finds the higher melting point metallic soaps effective boundary lubricants under conditions of high unit loading and high temperature. High lateral adhesion between the molecules of the lubricant film is reported to be as important in boundary lubrication as attachment of the lubricant to the metal surface. This characteristic of lateral molecular adhesion is, in turn, dependent upon the melting point of the lubricant.

Other investigators(2) consider that both physical and chemical mechanisms account for the action of good boundary lubricants. Soaps are not regarded as the exclusive lubricants, since physically attached polymolecular layers also function as lubricants. It was further concluded that boundary lubrication is not limited by the melting points of soaps chemically bound to the sliding surfaces, although such soaps do function more effectively than physically adsorbed films in preventing seizure between metal surfaces at high temperatures and under high unit loads as in drawing.

Practical experience in the wire mill does reflect the use of higher melting point soaps and lubricants for coarser wire, heavier drafts, and higher speed drawing.

In discussing wet wire drawing of galvanized, the authors mention a special compound to minimize attack upon the zinc surface. It would be of interest to hear more about the special character of this material. We have found that the same type of soap — fat paste compound used for wet drawing bright steel wire is also suitable for zinc coated wire so long as the pH of the emulsion does not exceed about 9. Since the pH of many steel wet drawing emulsions is on the order of 8 to 8.5, serious stains or deposits are not frequently encountered with such fluids.

A special mineral-oil type emulsion is mentioned in this paper to resist "breakdown" in service from lime-salt formation. In wet drawing limed steel wire, where large quantities of lime get into the emulsion system, we have found it advantageous to use a compound containing a minimum of free fat and fatty acid, and incorporating mineral soaps. In the usual concentrations for steel wire drawing, the emulsion from this compound minimizes the insoluble soaps and salts otherwise formed by combination of the lime with fatty acids. Possibly the authors have reference to a similar approach on this problem.

There is one precaution, however, to be observed in the use of relatively alkaline emulsions such as just described. That is in the matter of drawing galvanized wire. The pH of the emulsion must be adequately low to prevent formation of white zinc salts on the wire.

Although commented on briefly in the paper, the use of compounded and additive type mineral oils for drawing steel wire and tubing perhaps deserves some further mention. This is particularly true of chlorinated oils used successfully in drawing of fine (0.010 in.), type 304 stainless steel aircraft wire. Typical operations are 15-hole continuous drafting of such wire through diamond dies at 1500 fpm.

Chlorinated oils have been adapted for drawing of some types of stainless steel tubing, application being by either predip of tubes or recirculation at the drawbench. Satisfactory results are reported.

In the interest of completeness, it might also be desirable to include some mention of the use of adhesives in drawing stainless steel tubing(3) a typical "dope" of this kind contains lithopone suspended in a solution of shellac in alcohol(4). Application is made by predip of tubes in solution and then drying the coating preparatory to drawing.

It is unfortunate that the authors' paper does not give press drawing lubricants the extent of attention devoted to wire drawing soaps and compounds. While press drawing of carbon steel is very commonly done with either water based emulsions or compounded mineral oils, there are many varieties of each. However, it is not intended to discuss these here. Current literature(5) offers fairly adequate information on such lubricants.

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2. "*Antiseizure Properties of Boundary Lubricants*," by R. E. Thorpe and R. G. Larsen, Industrial and Engineering Chemistry, Vol. 41, May (1949).
3. "*Use of Adhesives in Cold Drawing Stainless Steel Tubing*," by H. K. Ihrig, Steel, October 21 (1946).
4. "*Cold Working Metal*," U. S. Patent No. 2,223,037, to Harry K. Ihrig, November 26 (1940).
5. "*Metal Drawing*," by E. L. H. Bastain, Iron Age, Vol. 165, No. 7, February 16 (1950).

C. E. Pritchard: One point I want to offer in the way of general discussion is that covering the problems encountered when using these so-called lime substitutes. We have experienced in our operations considerable trouble in various instances due to excess foaming of the bath where lime substitutes were used in place of the conventional lime coating. When discussing drawing operations, too much cannot be said about the relative thickness of the lime coating, which is found to differ from plant to plant and actually from man to man. It is interesting to learn that studies have been instituted by representatives of American Steel & Wire Co. to correlate just such information as mentioned previously. The use of soap powders and lime soap greases such as cup greases are classified together with their general application as an adjunct to the lime coating. The lime coating thickness mentioned being determined more or

** Numerals refer to Bibliography at end of this discussion

less by the number of draughts taken, the type of steel, and the type of finish desired.

Some mention might be offered regarding further explanation of what is referred to in the paper as coarse wire versus fine wire. The general accepted definition being that 20 gage or 0.035 in. is called coarse wire, while anything below 20 gage is defined as fine wire.

As a typical example, the lime soap greases are usually employed when one to three draughts are taken on stock up to one inch and reductions of 1/32 to 3/32 of an in. are taken.

Soap powders are usually preferred when four or more draughts are taken. Fillers or combinations of fillers are also employed in order to cover the overall draughting range. The soaps are usually found to be satisfactory lubricants when used straight, whereas the fillers are seldom satisfactory by themselves, with the possible exception of such materials as graphite and molybdenum disulphide.

It would be interesting to learn if the author has had any experience regarding these latter mentioned materials, namely graphite and molybdenum disulphide. Do the peculiar properties of these materials make a satisfactory contribution to the slippage factor of the drawing lubricants either when used in their natural form or as an admixture with either greases or oils?

It has been our opinion that the one serious disadvantage we find in this regard has been the high cost of molysulphide even in combination with other materials. Also the problem of removing the graphitic deposit remaining on the wire after a drawing operation has taken place when graphite is employed as one of the so-called fillers, must be taken into consideration. The soap powders are usually composed of animal fats such as suet and tallow combined with soda ash and water and then dehydrated. Aluminum stearate and calcium stearate are typical products used throughout the industry. Both pigment and non-pigment drawing compounds are utilized in tube drawing operations. Considerable difficulty has been experienced with respect to subsequent removal of the pigment residue remaining to permit satisfactory further processing. Consideration must be given to this condition when selecting the drawing compound in order to minimize the attendant problem. Where conditions demand that you retain a coated tube in storage for more than approximately two days, this problem has been found to be quite troublesome. It is reported that recent developments in drawing lubricants make it possible to overcome this adverse condition. Simplification programs covering the removal of these deposits has become quite paramount in tube drawing operations due to the intricate shapes and surface finish standards demanded by the trade, all of which tends to aggravate the problem.

Deep and shallow drawing of metal has become quite a science due to the higher speeds and more intricate shapes being made. Unlike wire drawing operations where a low coefficient of friction is believed to be mandatory, the drawing of shapes from a given sized metal blank is found to require slightly higher coefficients of friction. This phenomenon is sometimes referred to as "wiping" which induces the metal to exert a wiping action in the die. This prevents excess wrinkling of the metal during the drawing operation. The compound must be non-corrosive to either the metal drawn or the die while also preventing welding of the metals from taking place. Ease of removal being also of considerable importance as in the drawing of tubing.

Walter A. Smigel: The comments made by Mr. Stalson are in very close agreement with the observations made in our paper. We do feel, however, that his diagrammatic explanation of the effect of richness on wire drawing represents an important addition.

Isn't it true, Mr. Arnold, that one of the disadvantages of a tallow and flour mixture lies in the fact that the tubes must be stored long enough to allow the lubricant to set-up; that is, to give them ample time for the reaction to take place so that you have a suitable coating?

Karl A. Arnold: We dip the tubes in a large vat and then they are oven-dried. When they are dry, it is permissible to draw them immediately.

Walter A. Smigel: I understood there was a chemical reaction necessary between the lubricant and the surface of the tube. Apparently that is not the case.

Karl A. Arnold: This drying procedure has been our standard practice for quite a few years.

Walter A. Smigel: I understand that you have been very successful with the tallow and flour combination. However, most manufacturers at the present time are using an undercoating plus a lubricant on large size tubing.

Mr. Bastian had a question regarding drawing galvanized wire. Because of the amphoteric nature of zinc, it is susceptible to attack from both acid and alkaline materials. Ideally, therefore, a neutral lubricant should be used. The particular lubricant we had in mind is manufactured from an organic alkali and a soluble type wax giving a lubricant which is buffered against wide variation in the alkalinity. We believe this type of lubricant has been a little better than the ordinary straight soap lubricant.

We thank Mr. Bastian for mentioning the lithopone and shellac mixture for use in drawing stainless steel. It is true that this method was used quite extensively by a large tube manufacturer in the mid-west. However, they have recently changed over to a ferrous oxalate undercoating plus a standard emulsion-type lubricant.

Mr. Pritchard asked about the use of graphite and molybdenum disulfide in lubricants. We have had no experience with the molybdenum sulfides. While graphite has long been known as an aid to lubrication, we have not employed graphite in our wire drawing lubricants because most operators dislike it. The only really good way to remove the carbon smut of the graphite is by burning it off and this is impractical in many applications. The operators also object to getting the graphite on their hands.

H. Gray Verner: May I comment on Mr. Pritchard's observation of foaming difficulties with lime substitutes? We have not encountered this difficulty in the lime substitute baths which we have installed. The lack of foam may be explained on at least two bases. First, the lime substitute should not contain soap or other detergents which would give the foam characteristics mentioned by Mr. Pritchard; secondly, if the lime substitute contained soda ash, then acid drag-in from the pickling operation prior to the undercoating would cause the evolution of carbon-dioxide gas which might

contribute to foaming, particularly if soap were a component part of the mixture.

C. E. Pritchard: I would like to ask Mr. Smigel what type of lubricant is being used for hot drawing operations?

Walter A. Smigel: Our business does not carry us into that field of lubrication, however, I understand that a suspension of collodial graphite in oil is the usual lubricant.

E. L. H. Bastian: I would just like to make a comment on Mr. Pritchard's question on the use of graphite and molybdenum-disulphide. We have had some experience in the use of graphite in greases for drawing operations and with reasonable success, except that the graphite always introduces some problems in cleaning.

With regard to molybdenum-disulphide, I understand by reports that manufacturers of the material did incorporate some of it into our compound in one drawing application under typical conditions. It was a matter of making a heavy-slurry emulsion and pre-coating. The molybdenum-disulphide was introduced into the slurry emulsion. According to reports, the drawing compound did show some improvement with the addition of the molybdenum-disulphide.

In considering the use of such additions to the compound, however, there are generally two factors that need to be taken into account. One is the matter of cost. I believe the current market on molybdenum-disulphide is about a dollar a pound. If used in adequate quantities to be effective, it might work some hardship there. Number two is the fact that the immediate difficulty, and it is a difficulty that is self-explanatory, is that it is heavy. While it might be expected to perform satisfactorily in an oil type fluid and other viscous fluids, there is some question as to whether it could be suitably put into an emulsion because of its settling tendency.

Member: There are cheap forms of the disulphide coating available for drawing. When you put the sulphide on the stock you have to draw it in the same manner that you would for a phosphate.

R. E. Griffiths: We have experimented with the use of molybdenum-disulphide as a lubricant for the cold drafting of steel wires. The structural properties of this mineral make it an interesting material for extreme pressure lubrication, such as is encountered in the cold reduction of metals.

Results with the use of this material were encouraging and it was possible to draw wires a number of successive drafts. However, the cost of the product is quite high in comparison with the usual lubricants; and, too, since it is a mineral mined from the earth it contains silica which must be removed to prevent premature die failures.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

CLEVELAND SECTION

Cleveland, Monday, May 21, 1951 — Dinner 6:30 P.M., Meeting 8:00 P.M.

Youngstown, Tuesday, May 22, 1951 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Metals for Service at Elevated Temperature" by Howard Scott, Manager of Metals and Ceramics Dept., Westinghouse Research Laboratories, E. Pittsburgh, Pa.

Cleveland: Cleveland Engineering Society, 2136 E. 19th Street, Cleveland, Ohio.

Youngstown: El Rio Club, Youngstown-Warren Road, Route 422, Youngstown, Ohio.

PHILADELPHIA SECTION

Tuesday, May 22, 1951 — **Inspection Trip** — Alan Wood Steel Co., Ivy Rock and Swedeland, Pa. — 10:30 A.M.

Alan Wood Steel Co., which is celebrating its 125 Anniversary, is inviting the members of the Association of Iron and Steel Engineers to visit its plant at Ivy Rock, Swedeland, and Conshohocken, Pa. The group will assemble at the Steel Works division at Ivy Rock, and the trip itself will start promptly at 10:30 A.M. The trip is limited to citizens of the United States and Canada, and also only to those who have made a reservation prior to noon Monday, May 21. Reservations for the trip should be made to Linn O. Morrow, 1505 Race Street, Philadelphia 2, Pa., and should indicate whether the person making the reservation will arrive by train.

Those traveling by train should leave Reading Terminal at 10:20 A.M. arriving in Conshohocken at 10:45 A.M., where they will be met by bus. Those traveling by automobile to the plant will park as indicated by signs near the steel works division.

PROGRAM

ANNUAL SPRING CONFERENCE

SPONSORED BY

THE ROLLING MILL COMMITTEE

OF THE

ASSOCIATION OF IRON AND STEEL ENGINEERS

HOTEL STATLER

DETROIT, MICHIGAN

APRIL 30 - MAY 1, 1951

An Invitation . .

The unprecedented, record-shattering expansion now planned for the iron and steel industry is proceeding at a rate deemed impossible only a short time ago. New and ingenious ideas for equipment, better production techniques and improved maintenance practices developed at individual plants are reflected in the industry's greater capacity for production. Many of these developments which have not had industry-wide circulation will be covered at the 1951 Annual Spring Conference of the Association of Iron and Steel Engineers.

You will find it worth your while to attend, and a cordial invitation is extended to you to do so.

JOHN F. BLACK

President, AISE

WALTER L. KEENE

L. C. SOWELL

HOWARD S. AVERY

WARD HOLLAND

Annual Spring Conference Program

MONDAY, APRIL 30, 1951

9:00 a.m. — Registration — Assembly Hall, Ball Room Floor

9:30 a.m. — Rolling Mill Session — Wayne Room

Co-Chairmen:
James N. Imel
Jones & Laughlin Steel Corp.

Paul Carnahan
Great Lakes Steel Corp.

1. "An Introduction to Clad Metals"
   Walter L. Keene, Director of Research
   Superior Steel Corp.
2. "Washington Steel Corp.'s 39-In. Sendzimir Cold Rolling Mill"
   T. S. Fitch, President
   Washington Steel Corp.

9:30 a.m. — Mechanical Session — Michigan Room

Co-Chairmen:
James J. Healy
Armco Steel Corp.

Charles E. S. Eddie
Great Lakes Steel Corp.

1. "Hard Facing Alloys for Steel Mill Use"
   Howard S. Avery, Research Metallurgist
   American Brake Shoe Co.
2. "Modernization of Lubrication for Old Mills"
   Ward Holland, Lubrication Engineer
   Republic Steel Corp.

2:00 p.m. — Rolling Mill Session — Wayne Room

Co-Chairmen:
C. P. Hammond
Rotary Electric Steel Co.

Wade F. Hoffman
Jones & Laughlin Steel Corp.

1. "The Layout and Operation of Bar Mill Finishing and Shipping Departments"
   L. C. Sowell, Superintendent of Blooming and Rolling Mills
   Jones & Laughlin Steel Corp.
2. "Processing Inquiries and Orders for Hot Rolled Sections"
   W. H. Mohler, Superintendent Roll Shops
   United States Steel Co.
3. "Rolling Characteristics of Various Steels"
   Edgar Herold, Superintendent Finishing Mills
   Crucible Steel Co. of America

2:00 p.m. — Electrical Session — Michigan Room

Co-Chairmen:
A. J. F. MacQueen
Algoma Steel Corp.

H. H. Angel
Bethlehem Steel Co.

1. "Handling and Storage of Electrical Parts"
   A. W. McAuly, Superintendent Electrical Department
   Edgewater Steel Co.
2. "Emergency Drive Arrangements for Blooming Mill Auxiliaries"
   F. C. Fennell
   Industry Engineering Department
   Westinghouse Electric Corp.
3. "Developments in D-c Current Drives for Hot Strip Mill Runout Tables and Coilers"
   H. E. Larson
   Steel Mill Division
   Industrial Engineering Divisions
   General Electric Co.

7:00 p.m. — Informal Dinner — Grand Ball Room

Speaker: Richard "Dick" E. Roberts
Manager of Employees Relations Department
Ford Motor Co.

T. S. FITCH

W. H. MOHLER

EDGAR HEROLD

A. W. McAULY

TUESDAY, MAY 1, 1951

9:00 a.m. — Rolling Mill Session — Wayne Room

Co-Chairmen:
D. W. Lloyd
Youngstown Sheet & Tube Co.

A. Krause
Ford Motor Co.

1. "Ingot Track Time — Its Affect on Soaking Pit Heating"
   J. R. Chegwidden, Superintendent of Mills
   Saucon Division
   Bethlehem Steel Co.
2. "Descaling of Carbon Steels in Modern Merchant Mill Practice"
   C. S. Lambert, Superintendent Merchant Mills
   The Youngstown Sheet and Tube Co.

F. C. FENNELL

9:00 a.m. — Combustion Session — Michigan Room

Co-Chairmen:
E. T. W. Bailey
Steel Co. of Canada, Ltd.

A. F. Kritscher
National Tube Co.

1. "The Application of Precast Insulation to Water-Cooled Supports in Underfired Furnaces"
   James E. Hovis, Sales Engineer
   Bloom Engineering Co., Inc.
2. "Metallic Recuperators for Slab Heating Furnaces"
   R. R. Shedd, Design Engineer
   Construction Engineering Bureau
   United States Steel Co.
3. "Some Aspects of Soaking Pit Operation"
   F. H. Graham, Chief Operating Engineer,
   Amsler-Morton Corp.

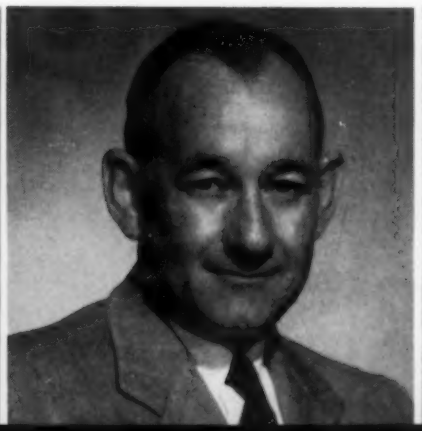
H. E. LARSON

1:00 p.m. — Buses leave Hotel Statler for Inspection Trip to Ford Motor Co. covering steel plant and automobile assembly line.

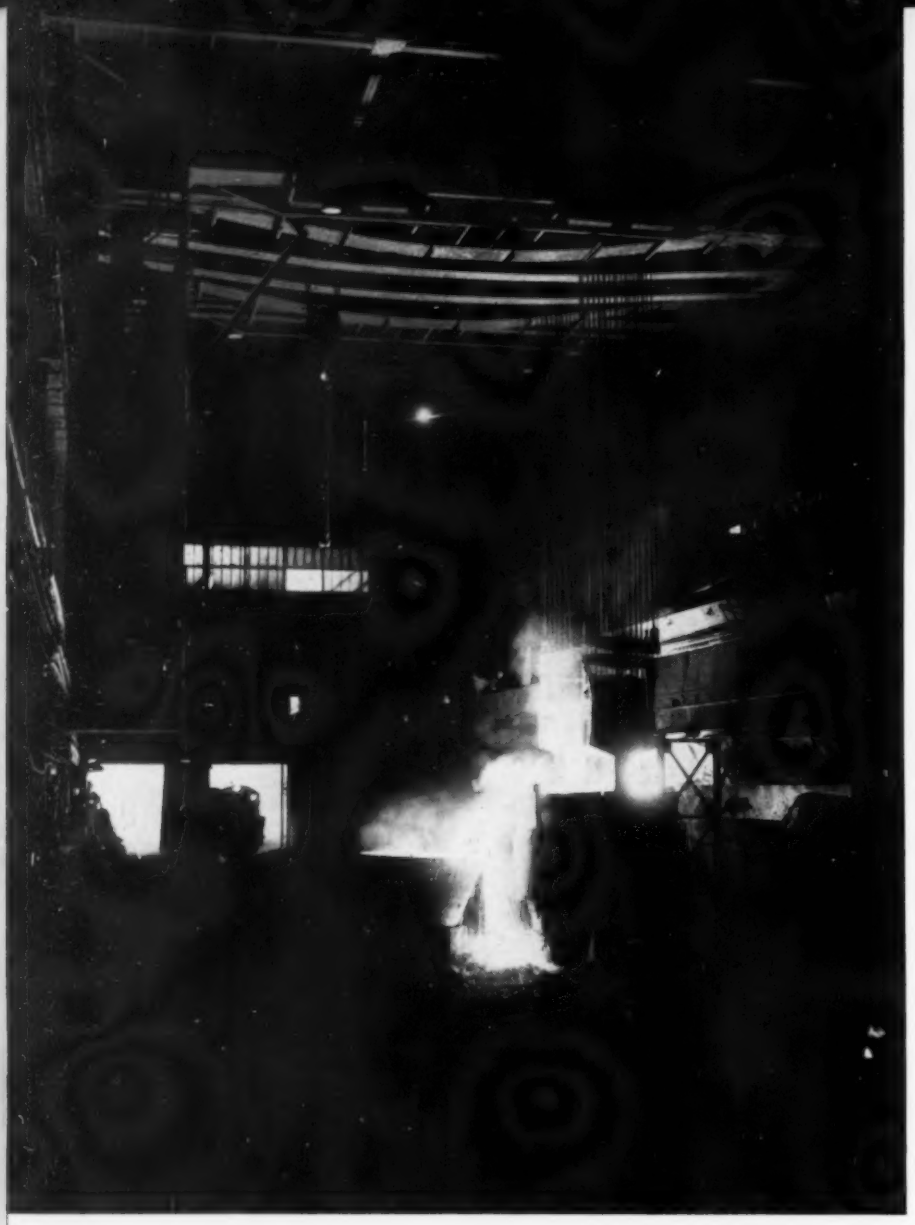
JAMES E. HOVIS

R. R. SHEDD

J. R. CHEGWIDDEN



C. S. LAMBERT



TUESDAY
MAY 1, 1951

AISE
INSPECTION
TRIP

TO

FORD MOTOR COMPANY

RIVER ROUGE PLANT

DEARBORN, MICHIGAN

Buses leave Bagley Street entrance of Hotel Statler at 1:00 p.m.
Trip will cover both the steel plant and the automobile assembly line.
Trip is restricted to citizens of the United States and Canada only.

ABSTRACTS OF TECHNICAL PAPERS

FOR

Annual Spring Conference

April 30-May 1, 1951

Detroit, Michigan

AN INTRODUCTION TO CLAD METALS

By WALTER L. KEENE
Director of Research
Superior Steel Corp.
Carnegie, Pa.

▲ THE need for conservation of critical metals was never so important as at present. In order that the less abundant but commercially important metals, as copper, nickel, chromium and others, be made available in sufficient quantities for defense as well as commercial requirements, it is suggested that ways and means of combining these critical metals with others more abundant, be considered. One of the best ways of making use of the distinctive properties of these scarcer metals is to clad them to other metals.

Clad metals are defined as those which consist of two or more metallic components, the smallest being at least 3 per cent of the total mass, the components being arranged in layers with the smallest generally at a surface, inseparably bonded in a rolled product.

More than twenty different methods of cladding have been developed, most of which can be included in one of the following five general classifications: pressing, casting, direct rolling, sintering and deposition. The method chosen to make the clad metal depends on characteristics of the components, properties of the finished product and facilities available.

The greatest source of information on clad metals resides in the U. S. patent files. A list of some 150 workers in the clad metal field, who have nearly 300 U. S. patents to their credit, has been compiled. This list is necessarily incomplete, for an exhaustive search has probably not been made. However, those interested in the subject will find enough information and "argument for the cause" to justify spending a little time in the U. S. Patent Office files.

Because of the urgent need for conservation of critical metals as well as the possibility of obtaining most unusual properties by cladding one metal to another; and of lesser importance at present, the opportunity of effecting economies in costs, this discussion is presented with the hope that it will arouse the interest of engineers, designers and consumers alike.

WASHINGTON STEEL CORPORATION'S 39-IN. SENDZIMIR COLD ROLLING MILL

By T. S. FITCH
President
Washington Steel Corp.
Washington, Pa.

▲ THE paper describes how the mill was selected and put into operation. The factors which enter into the selection of such a mill were influenced to a large degree by the philosophy of attaining equal or better results with fewer dollars invested, and particularly important are the non-engineering aspects such as competition, prejudice and previous experience. The discussion is limited to stainless and alloy steels, and the conclusions may not necessarily apply to carbon steels. After the selection of the general type of mill, it was necessary to establish a number of mechanical details, and the paper describes why the operators selected the Sendzimir mill, the 1-2-3-4 cross-section, 1⅝-in. work rolls and the speed range. The mill has a potential cold reduction on 18-8 of 18 to 22 per cent per pass which is appreciably higher than most other types of cold mills. The paper describes the importance of tolerances and lubrication. The electrical design factors such as mill and reel horsepower, tension control system, mill speed control and overload are covered in the paper.

Of particular interest are the operating results such

as the tonnages rolled, maintenance costs per shipped ton, quality, and on the other side of the ledger, the troubles which had to be overcome on the pinion stand, taper control, lubrication and bearings. The operators are "sold" on the mill for rolling alloy steels, and opinions are given by the author on its application to carbon steels.

HARD FACING ALLOYS FOR STEEL MILL USE

By HOWARD S. AVERY
Research Metallurgist
American Brake Shoe Co.
Mahwah, N. J.

▲ A MODERN classification of hard surfacing alloys is outlined in the paper. The most important types are described in some detail, and the factors to be considered in selection are discussed.

The salient types, listed in approximate order of decreasing abrasion resistance and increasing toughness are:

Material	Features
1. Tungsten Carbide composites.	Maximum abrasion resistance. Worn surfaces become rough.
2. High chromium irons.	Excellent erosion resistance. Oxidation resistance.
3. Martensitic irons.	Excellent abrasion resistance. High compressive strength.
4. Cobalt base alloys.	Oxidation resistance. Corrosion resistance. Hot strength and creep resistance.
5. Nickel base alloys.	Corrosion resistance. May have oxidation and creep resistance.
6. Martensitic steels.	Good combinations of abrasion and impact resistance. Good compressive strength.
7. Pearlitic steels.	Inexpensive. Fair abrasion and impact resistance.
8. Austenitic steels. Stainless steels. Manganese steel.	Work hardening. Maximum toughness with fair abrasion resistance. Good metal to metal wear resistance under impact.

There are related and transition types, but where simplification is desirable, this group will serve most purposes.

Carbon is very important as an element controlling properties in most of these types. Together with the welding method, carbon exerts a potent influence on the performance of weld deposits.

The important properties of erosion resistance, abrasion resistance, oxidation resistance, hot hardness, and impact resistance are summarized to permit exercising the judgment in choice that is usually necessary. Hot hardness is particularly important for many steel mill applications and must be balanced against the need for toughness and abrasion resistance.

Oxyacetylene welding is likely to add carbon to the deposit. This carbon generally increases abrasion resistance and decreases toughness. Gas welds tend to be smoother and easier to make with precision, but the welding method may be costly.

Arc welding is less expensive, and may be much faster. It is usually the preferred shop method, but has the disadvantages of sharp thermal gradients that may lead to cracking, a loss of carbon with its effect on wear resistance, and rougher deposits. Arc welds, except where cracking is induced by thermal stresses, are generally tougher than the same material after gas welding.

The major cost in hard facing is likely to be labor, welding gases, and the like. The cost of the hard facing alloy may be small in comparison. This suggests that it is false economy to use inexpensive alloys when high performance grades, even if more expensive, are available. The chief justification of low cost steels for hard facing lies in their generally superior toughness.

THE LAYOUT AND OPERATION OF BAR MILL FINISHING AND SHIPPING DEPARTMENTS

By L. C. SOWELL
Superintendent of Blooming and Rolling Mills
Jones & Laughlin Steel Corp.
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▲ THIS paper will cover the essential points regarding the layout and efficient operation of a bar mill, finishing and shipping department. Various layouts and units of the Jones & Laughlin Steel Corp. will be described and discussed. Some of the essentials for such a unit are adequate floor space to accommodate the storage of material, and proper reconditioning and handling of same. Layout should also be such that movement is minimized and flow proceeds in an orderly and efficient manner. Proper consideration should be given to both rail and truck shipment for delivery of steel to ultimate consumer.

MODERNIZATION OF LUBRICATION FOR OLD MILLS

By WARD HOLLAND
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▲ THE need for modernization of lubrication equipment in steel mills is probably more evident today than ever before. Production schedules, at present, do not permit shutdowns of sufficient time for proper lubrication by hand methods. An eight hour repair period or

one turn per week will possibly permit the mill to be gone over hurriedly with no rhyme or reason given to the amount of lubricant pumped into a bearing. This "once over" is expected to last a full week. Under the conditions which production machinery operates, is it folly to expect lubricant to last for such a period of time?

Hazards to personnel will not allow lubrication during operation. Shutdown time to permit lubrication is delay time and must be avoided if at all possible. So, too, we must avoid operation failures due to lack of lubrication. In short, preventive maintenance must be at its best.

These facts lead to the modernization of lubrication equipment as a must. Installation of centralized greasing systems, lubricators, oil feed cups, changing from oil to grease application and other methods to eliminate hand lubrication is the only approach to these problems. While such systems, at times, leave something to be desired, they do insure application of lubricant to moving parts during operations.

When mill equipment now being discussed was designed, little or no thought was given to application of centralized systems. Therefore it is necessary to devise some means of satisfactorily installing such equipment. Ingenuity of mill men together with the manufacturers of centralized equipment has given a solution to this problem, sometimes not always the perfect answer, but at least a result far better than hand methods.

Centralized systems, wherever possible, should be of the automatic type. This eliminates the human element in application of lubricants or reduces it to a minimum. Also this type of system more nearly assures the proper proportions of lubricant to various parts of the equipment. The human element in such cases is confined to inspection of the systems during shutdown periods. Automatic systems will reduce manhours to an absolute minimum and this savings alone will underwrite the cost involved in the installation.

Where automatic systems are not feasible, the semi-automatic pumping station must be used. Manhours are greatly reduced with this type as it does not require any more time to pump lubricant into several bearings from a central point than is required to lubricate one bearing with a hand gun, especially if such a bearing is not in a readily accessible location.

In the process of modernizing lubricating equipment, another step must be taken in preventive maintenance. This is to place the responsibility in the hands of a higher type individual. This individual must be properly trained to the functions of modern systems. He must also be properly equipped. This equipment means proper tools and a location to make running repairs when necessary.

A further step, and one of utmost importance, is the establishment of a lubrication repair shop and lubrication repairmen of sufficient number to maintain the systems in use. The shop must be equipped to make repairs to all lubrication equipment. It must also have the necessary installation tools.

The lubrication repairmen must be properly trained in the maintenance of all systems, and they must inspect all systems periodically. By so doing, they can often locate trouble overlooked by operators, where possible, repairs are made in the field. If impossible to repair the damaged part in this manner, a spare is substituted and the inoperative part returned to the shop to be repaired and placed in spare parts storage for future use. The repairmen can also be used in a supervisory capacity during installations of additional or new systems by outside contractors. This will insure proper thought is given for future maintenance.

Such a plan, as outlined, cannot be instituted over night. It must be planned ahead and followed with utmost diligence until completed. Such a plan will return its cost many times.

ROLLING CHARACTERISTICS OF VARIOUS STEELS

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▲ THIS paper describes the rolling characteristics of various analyses of steels, carbon, alloy and stainless grades. The properties that carbon, manganese, silicon, chrome, nickel, molybdenum, etc., impart to the steel will be discussed and examples of merchant bars, rounds and squares, rolled on a 24-in. mill, 12-in. mill and 8-in. mill will be shown. These examples show the same size bar of various analyses steels, rolled in the same passes, to show the effects obtained with varying additions of alloying elements.

These effects are shown primarily from the viewpoint of spread in the various passes. The question is raised as to how much these alloys effect the actual rolling. The heating of various grades of steel is described and the heating and rolling characteristics of some nickel steels are explained.

This paper deals solely with the rolling aspect of various steels and no attempt is made to explain the metallurgy of the process. It is written from the viewpoint of the mechanical rolling operation, and all data have been taken from actual commercial rollings.

EMERGENCY DRIVE ARRANGEMENTS FOR BLOOMING MILL AUXILIARIES

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▲ DUE to its importance as the initial rolling operation in the steel plant, considerable emphasis is placed

on insuring the continued operation of the blooming mill to prevent interruption of the flow of steel to the rolling mills and processing lines which follow. In both main and auxiliary electric drives, the problem of keeping the blooming mill in operation in spite of equipment failure receives much attention both from the electrical manufacturer and the steel plant operator.

Variable voltage auxiliary drives are usually supplied with power from individual generators. It is common practice to provide some means of transferring to an emergency power source in case of failure of a generator or its associated control. The number of variations of emergency arrangements is practically unlimited, but the majority of installations fall into several main categories including: (a) emergency operation from one of the drive generators; (b) provision of a standby generator and controller; and (c) duplication of generators. As a basis for comparison, consideration is given to a typical blooming mill having variable voltage drives on main tables, feed rollers, screwdowns, and manipulators; but having no provision for emergency operation. Initial equipment cost, floor space requirements, installation cost, maintenance, and mill performance under emergency operation are some of the points of comparison.

The selection of the ideal emergency arrangement for a particular mill requires an evaluation of all the factors involved.

HANDLING AND STORAGE OF ELECTRICAL PARTS

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▲ THE purpose of carrying spare parts is to reduce to the minimum the amount of delays to production, due to the failure of the production machinery to function. No one knows exactly what parts are going to fail in service, or when, but long experience has taught steel mill maintenance men that they can depend on the certain need for such parts as spare armatures, bearings, control, gears, cables and a host of other parts peculiar to the individual plant.

A portion of the delay time is the time required to first determine whether or not a spare part is on hand; where it is stored; possibly making out a requisition for the part before it is released from stock; and finally transporting it to the place of installation. This time, in many cases, has exceeded the actual time required to install the part.

Some delay costs are extremely high, and therefore it is desirable to have spare parts available almost at once, while at the same time not obstructing working areas with stored equipment.

The older plants tend to acquire a large number, and a wide variety, of items of this character. If an accurate accounting is to be kept of the movement of this material, it must be stored in a warehouse or stockroom, and released to the maintenance department on a stores order, or else a frequent and careful inventory must be made in an effort to square the storage account with the material on hand. Maintenance men are not generally much concerned about accounts; they want the material in a hurry, but good business dictates that certain accounts must be kept. Therefore, a workable method should be found, if possible that will be satisfactory to both departments.

It is perhaps impossible to completely eliminate all undesirable features in a storage system where the material is not kept under lock and key, and it may well be that some things that might be tolerated in one plant would not be acceptable in another.

This paper will describe a system for making spare parts readily available and their inventory easy, while at the same time allowing for a reasonably accurate accounting for the movement of the material. The system is based on the idea that a certain time lag, between the issuing of the requisition to the storage department, and the actual installation of the part on the machine, is permissible where movement of the material is fairly regular over a period of years, for example, in a plant that runs for long periods without expansion or contraction. In such cases the flow of material assumes a pattern that readily accommodates itself to this system. Where this can be done it will definitely cut delay time.

DEVELOPMENTS IN D-C CURRENT DRIVES FOR HOT STRIP MILL RUNOUT TABLES AND COILERS

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▲ DIRECT current drives for hot strip mill runout tables and coilers were first seriously considered in 1936 and first installed in 1937, on three hot strip mills. From this beginning, d-c drives have been applied to both the tables and coilers of 36 hot strip mills. Since 1937, two other mills have installed d-c drives for coilers only, and one other mill has installed d-c drives for tables only.

Operating experience with d-c drives has been so satisfactory that in several of the above instances, a-c adjustable frequency drives have been replaced by d-c drives. Two mills have replaced a-c drives for both tables and coilers with d-c drives. Two mills have replaced a-c table drives and one mill has replaced a-c coiler drives with d-c drives.

It will be the purpose of this paper to discuss and summarize the development and improvements made in electric equipment for d-c drives against this broad background of operating experience.

The following *runout table drive developments* will be discussed and summarized:

1. Time-tested methods of driving table rolls and mounting motors.
2. Roll spacing and its effect on table performance and drive costs.
3. Number of table sections desirable for various types of mills.
4. Table speeds for various operating conditions and speed-synchronization with the mill.
5. Selection of table motors based on operating test data.
6. Design improvements in d-c table motors, such as water-tightness, built-in surge and temperature protection, exceptionally good commutating performance with high peak loads and simplified bearing lubrication.
7. Improved motor protective controls.
8. Rotating regulator type improved generator controls.

Developments in coiler drives for principally expanding downcoilers and the newer mandrel type down-and-up coilers will be discussed.

These are:

1. Specially designed motors for space restricted coiler rolls and wrapper rolls.
2. Pinch roll drives—with and without generator supply.
3. Selection of motors for mandrel drives—industrial or mill type.
4. Speed matching control for pinch roll drives.
5. Tension and speed matching control for mandrel drives.
6. Solenoid valve control systems and solenoid protection.

INGOT TRACK TIME—ITS EFFECT ON SOAKING PIT HEATING

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▲ TRACK time, the time consumed for the delivery of a heat of steel from the open hearth to the soaking pits, is measured in hours and minutes, and evaluated in terms of temperature or heat content remaining in the ingots as received by the soaking pits.

As good track time is vital to the economic life of a soaking pit operation, an analysis, in time and temperature, must be made of each operation included in its measurement. These operations, in order of their influence to track time, in this paper, are listed as follows:

1. Teeming and solidification.
2. Transportation.
3. Stripping.

Recognizing that different kinds of steels, molds, and mold sizes, vary in degree of effect to the subject, the writer confines all data and conclusions to semi-killed, low carbon steel, and big-end-down molds.

Relative temperatures of the ingot, inside and outside, at various stages of track time, are established for a given size ingot, to illustrate the temperature drop comparison between fast and slow movement of heats to the soaking pits.

By using immersion thermocouples, radiation pyrometers, and optical pyrometers to measure and check the temperatures of ingots, in each phase of cooling and heating, from liquid state to rolling temperature, sufficient data is obtained for a given size ingot, to more accurately evaluate the heat content of the ingot as received at the soaking pits. The optical pyrometer has a practical use in this evaluation.

The importance of the mould stripping location is emphasized through the comparison of the cooling curves of ingots exposed to the atmosphere and of ingots within the moulds.

The wide range in fuel consumption and heating times obtained through soaking pit heating data clearly indicates the necessity of fast delivery of ingots from the open hearth to the soaking pits, to secure an economic operation.

DESCALING OF CARBON STEELS IN MODERN MERCHANT MILL PRACTICE

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▲ FOR many years the merchant mills of this country have been confronted, and still are to a lesser degree, with the age old problem of surface quality. This problem includes producing a bar free of rolled-in scale, slivers, tearing, shearing and any other abnormal condition which would not properly cleanup for its application in a cold drawn bar or where the end product is extruded or polished.

Greater emphasis is being placed today on hot rolled bars than ever before, due to the ever increasing number of applications, more exacting metallurgical requirements, rolling of higher grades of carbon and critical alloys, and in many cases its substitution for material previously forged. The operator of the merchant mill of today must be acutely aware of the greater demand for quality, and cognizant of the methods by which many of the defects can be readily prevented or removed.

As you are all aware, scale removal is of primary importance, and the main source of many of our quality problems in the rolling of rounds, flats, and hexagons.

Primary scale, if allowed to adhere to the bar and rolled in the roughing train, generally will fall out in spots in succeeding finishing passes leaving a depression in the finished bar. In addition rolled-in-primary scale which does not fall out in the rolling of merchant mill bars will often show up as scale pits in a bar after pickling.

The chief characteristic of secondary or thin scale if not properly removed is to produce a scale mottle on the finished bar which normally cannot be removed in pickling, therefore not being applicable to the end product where a bright finish is required.

For many years operators have experimented with numerous mechanical devices for removing scale such as scrapers, hold downs, and wire brushes which were followed by the application of steam, compressed air, and high pressure water. Of all these devices and methods, high pressure water has proven to be the most economical and effective means of descaling carbon bars in the merchant mills of today. However, the installation of high pressure water alone will not guarantee good quality unless it is wisely placed and used where it can be most effective, as indiscriminate use can get an operator into more trouble than the problem for which intended, that of scale removal.

One important factor which cannot be overlooked in high-pressure descaling is the danger of excessive cooling of the bar by the use of too much water. This can be controlled by a careful analysis of the size of the section at the point of descaling, and controlling the amount of water by the size of the nozzle orifice. The author does not mean to imply that a larger stock of sprays must be maintained with varying sizes of orifices, but that two to three sizes have proved to be ample where properly utilized.

In retrospect the use of high-pressure water, when properly utilized, insures a clean bar free from rolled in scale, increases roll life by proper cooling of the roll pass, reduces delays due to changing and grinding guides, reduces slippage in the roughing mills, and overcomes shearing to a great extent.

THE APPLICATION OF PRECAST INSULATION TO WATER-COOLED SUPPORTS IN UNDERFIRED FURNACES

By JAMES E. HOVIS
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▲ HEAT loss to cooling-water in underfired steel mill furnaces represents a substantial percentage of fuel input. An 80 per cent reduction in this loss can be effected by the application of insulation to the water-cooled skid and support pipes, and an overall fuel savings of 20 per cent can be realized. In a number of cases where fan, burner and stack capacity limit furnace capacity, a substantial reduction in fuel input such as this can increase furnace production by as much as 10 per cent.

In addition to the above considerations, if the steel heated is relatively thick, that is 12 in. or more, several serious problems arise which are a direct result of excessive heat loss in the bottom zone or of the effect of cold pipes located in close proximity to hot steel.

Specifically, these problems include excessive scaling and slagging, non-uniform heating through top and bottom surfaces, and skid marks. Also to be included is a situation which arises during a mill delay. Billets located immediately over a crossover during a delay will cool considerably, such that a marked temperature difference will develop between these billets and the ones adjacent to them. This temperature difference cannot be eliminated and, in most cases, these billets cannot be rolled. The increase in skid and support pipe surface temperature and the consequent decrease in heat loss to the cooling-water attained by the application of insulation substantially overcomes these problems.

It is the purpose of this paper to describe a precast insulation, the advantages derived from its use, the method of application, and its limitations.

METALLIC RECUPERATORS FOR SLAB HEATING FURNACES

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▲ IN late 1946, an installation of metallic tube type recuperators was made on five new slab heating furnaces. These furnaces are conventional triple-zone continuous furnaces having a nominal capacity rating of 105 tons per hour, and an estimated fuel consumption rate of 1,650,000 Btu per ton, designed for coke oven gas firing, but operated to date on fuel oil, natural gas, or a combination of these fuels. The recuperators designed for the installation comprised ten boxes of tubes, each box containing two rows of ten tubes each, making a total of two hundred tubes or heating elements. Only 80 per cent of the heating surface is installed. Fabricated stainless steel (25Cr - 12Ni) sheets, formed into cylinders, are used for the tube, with an inside tube open at both ends and suspended from a cold air plenum chamber, inserted into an outside shell closed at the bottom, and secured at the top in the hot air plenum chamber. Cold air flows downward through the inside tube, and is returned in the

annulus formed by the outside tube and into the hot air plenum chamber. With flue gases ranging from 1700 F to 1800 F, the temperature of the combustion air leaving the recuperator averages around 700 F, when volume demands are at the maximum of 45,000 cfm. With the designed recuperator area installed, furnace exit temperatures of 1600 F are expected with combustion air temperature of 800 F.

Operation of the slab heating furnaces is completely automatic, incorporating protective measures for overheating of recuperator tube surfaces. Under optimum working conditions, air delivered by a 45,000 cfm capacity fan (20 in. static pressure) provides adequate cooling to maintain tube surfaces substantially below that of the maximum allowable temperature, arbitrarily established in this instance at 925 F (25Cr - 12Ni stainless will withstand continuously 1600 F). The most severe service condition occurs during sporadic furnace operation when heat radiation from adjacent brickwork becomes intense. A constant minimum flow of air is maintained through the recuperator at all times, bleeding off excess air through valves actuated by thermocouples located in the highest temperature zone of the recuperator.

Sufficient time interval has elapsed since the initial installation to evaluate the effect of the recuperators on furnace efficiency and production. Fuel consumption per ton of product, due in part to the high heat exchange and negligible leakage characteristics of the recuperators, is as low as any known similar type of installation. Maintenance of the fan and tubes has been exceptionally satisfactory to date.

SOME ASPECTS OF SOAKING PIT OPERATION

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▲ THE purpose of the paper is to develop and discuss points that may be helpful in obtaining better soaking pit operation. After mentioning some physical requirements of a good soaking pit, such as its basic construction, the need for heat recovery equipment and automatic controls, the author compares the advantages and disadvantages of the large sized pit having a holding capacity up to a full open hearth heat with those of the smaller pit having a holding capacity of only a fraction of an open hearth heat. Then he discusses the essentials of good soaking pit practice, which are desirable for the ordinary grades of commercial steel ingots now being heated in many of the steel plants today; such points as hearth coverage, combustion, controls, the soaking-out period in the heating cycle, bottom making and a good maintenance policy. In other words, practices which are necessary for quality heating and maximum production at lowest costs. He also discusses the selection, training, and supervision of operating personnel.

PROCESSING INQUIRIES AND ORDERS FOR HOT ROLLED SECTIONS

By W. H. MOHLER
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▲ THE procedure followed by one large steel producer in processing inquiries and orders for special hot rolled sections is covered in detail in this paper. From the original inquiry to the shipment of the finished product, the process may be said to consist of three phases of development: (1) inquiry and quotation, (2) order and preparation, (3) development and production. In a large organization this procedure requires close cooperation of many departments in order to give the prompt service which is necessary, especially in submitting the estimated cost of production.

The formal inquiry is developed from a presentation of the problem by the customer to a sales or metallurgical representative and is prepared for mill presentation by the proper product sales manager. Copies of this inquiry are then forwarded to the plant, where they are distributed to the roll and operating departments for their consideration. In the roll department a preliminary study is made to determine how the section will be rolled and what the cost of necessary equipment will be. The operating departments determine the rate of production on the mill, conditioning necessary to the finished product, and any additional costs involved for special handling and/or packaging, etc. The details of these steps in the development of the inquiry are discussed. After all the costs and details of production are accumulated, they are forwarded to the sales department, where they are analyzed and an offer is submitted to the customer for his consideration.

Upon acceptance of the offer by the customer, production of the section begins the next phase of the development. A section number is first assigned. An order to proceed with preparation of rolls and equipment for the section is then forwarded to the departments involved. Upon receipt of the order by the roll department, prints of the section showing tolerances are forwarded to the customer for final approval. When this approval is received, a detailed roll pass design is made and templates, tools, rolls, and other auxiliary equipment are prepared. In the meantime the proper billet is procured and the section scheduled on the mill.

The final step of development begins with the test rolling of the section and ends with shipment of satisfactory product to the customer. It involves the perfecting of the roll passes and equipment for most efficient production.

HAZARDS OF BACK-DRAFTING

. . . . proper procedure must be used in back-drafting if explosions are to be prevented . . . .

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▲ WHEN the wind is taken off a blast furnace, a certain amount of pressure is maintained within the furnace. This is due to one or more of the following causes:

1. Chemical reactions which produce gas continue to "coast" for a time, even without blast. Among these reactions is that between solid coke and iron ore:
   $3C + Fe_2O_3 = 3CO + 2Fe$
   Also, the calcination of limestone continues:
   $Ca\,CO_3 + heat = CaO + CO_2$
   $CO_2 + C = 2CO$
   If a tuyere or other cooling copper has been recently burned and water has come into the furnace, the water gas reaction may also be proceeding:
   $C + H_2O = H_2 + CO$
2. The shut-off element of the snort valve may not come to tight closure, and hence a little blast may continue to reach the furnace. This source of residual pressure can usually be abated by closing all cold blast valves and the mixer valve, assuming that they provide tight closure; which, however, they may not always do.
3. Other furnaces on the same gas system may exert back pressure. This can definitely be stopped by closing the main seal or valve.

Cause (1) namely the continuation of chemical reactions is inevitable, and may go on for an extended period with gradually diminishing intensity. Immediately after shut-down, this cause proceeds with such vigor that as a rule it is not possible to neutralize the pressure in the furnace by opening the bleeder; at least that is ordinarily the case in the hearth and bosh region.

This residual pressure is usually insufficient to register on the blast gage in psi, but it imposes itself positively on any accessible part of the blast system, and it is sufficient to cause gas to issue copiously through any available opening. Such opening is provided when a tuyere, bosh plate, or other bronze must be changed. A hot blast valve, or any part of the hot blast main not capable of being isolated, comes within this category. The gas comes from an exceedingly hot region of the furnace. As a scrutiny of the above chemical reactions will show, the gas is very high in CO contents and possibly contains hydrogen in appreciable amount. Hence, immediately upon issuing from a tuyere or bosh plate opening, the hot, rich gas ignites in a flame usually so extended and aggressive as to make the approach of workmen most difficult and even impossible. Even if the gas does not ignite, as might be the case about a dismantled hot blast valve, it imperils workmen due to its highly asphyxiating property.

Back-drafting will neutralize the residual pressure in the hearth and bosh region by aspirating the gas through the hot blast main, through a stove, and up the chimney.

The usual reason for back-drafting, therefore, is to make it possible for men to work at or about openings which are made, as in changing tuyeres, coolers, blowpipes, boot legs, peep-sight caps, hot blast valves, etc.

Back-drafting may be desired for another reason, even though openings as above described are not to be made. If the wind is to be off the furnace for an extended period, (but not for one of such length as to call for plugging the tuyeres, dropping the blowpipes, and stopping the blowing engines), it is customary to slow down the engines. The pressure-volume characteristics of the air end of some blowing engines at very low speed may not always follow the niceties of a specification graph. This would be true of a reciprocating engine tub on which some air discharge valves might stick open during the suction stroke. On turboblowers, the natural pumping limit shown on specification graphs may not remain in exactly the same position after years of service. Moreover, it is not unknown for slow-moving blowing engines to come inadvertently to a dead stop. For these and other reasons, it may be possible for the residual pressure in an idle blast furnace to apply itself through open or untight valves back into the cold blast system, and to cause gas to penetrate thereto, thus, the entire blast system from the bustle pipe to the blowing engines could, and in fact has, become permeated with a mixture of air and highly combustible gas.

This is an obviously hazardous situation. There remains only the factor of ignition to produce an explosion of disastrous potentialities. Ignition could come from:

1. Sensible heat in the gas.
2. Pre-ignited elements or "slugs" of gas.
3. Low flash-point oil in the cold blast system.
4. Friction in blowing engines or other moving elements.
5. Static electricity.
6. Hot brickwork in stoves; particularly on the cold blast side due to punctured combustion chamber wall.

This hazardous situation can be prevented by back-drafting in such a way as to divert the gas from the blast system.

In summary, then, one purpose of back-drafting on idle blast furnace is the abatement of residual pressure. But the broader and more critical purpose is the complete and safe disposal of residually generated gas.

SAFE AND UNSAFE PROCEDURE IN BACK-DRAFTING

The bare essentials for back-drafting a blast furnace consist of opening the hot blast valve and a chimney valve on a stove. These two acts will abate the residual pressure. But, by themselves, they fulfill neither the spirit nor the letter of the broader purpose above named. The disposal of the gas may be neither complete nor safe.

Limiting the procedure of back-drafting to these two bare essentials in valve settings unquestionably has been in the past, and in some cases still is, the cause of accidents ranging from disconcerting "puffs" to disastrous explosions. Back-drafting, improperly done, not only fails to remove the hazards it is intended to remove, but in fact establishes hazards of its own.

The accessory measures that must accompany the bare essential ones in order to conduct back-drafting in a proper, effectual and satisfactory manner, are named below, with the reasons for each measure, and with a horrific word-picture of the ghastly results if it is not carried out.

The first criterion of proper back-drafting is that the disposal of gas be *complete*; that is, *all* of the gas must be conducted into a certain stove and up the chimney. There must be no vagrant gas going elsewhere. To this end a number of rules must be set down.

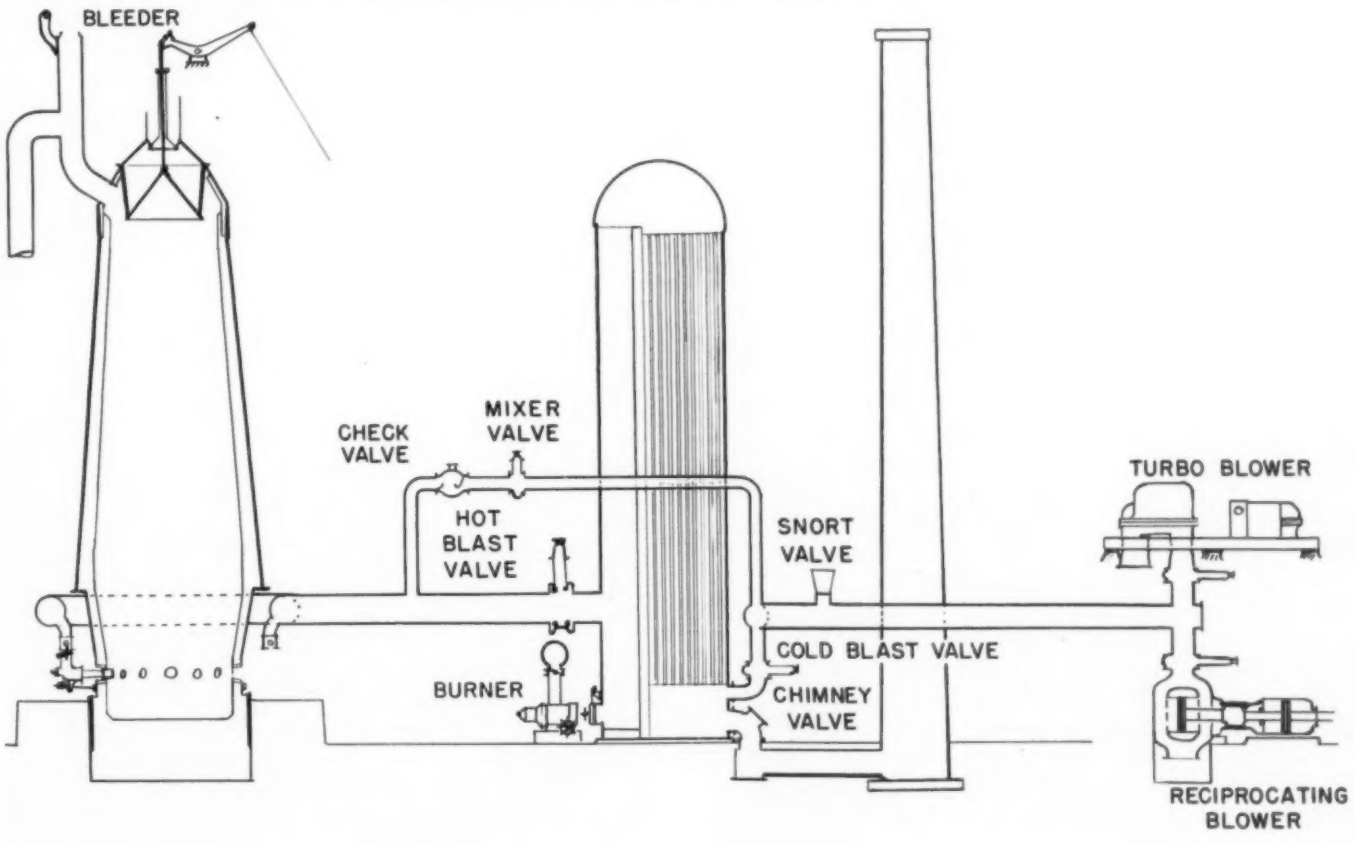
Rule 1. *The cold blast valve on every stove of the furnace must be closed. The mixer valve must be closed.* This should shut off access to the cold-blast part of the system. If passages are left open to the cold blast system, some gas could find its way thereto even though back-drafting is proceeding. This might occur if the blowing engines were to stop dead. The cooling of an erstwhile warm cold blast main could be a contributory factor.

However, valves may not be tight. Moreover, cold blast valves are usually constructed so as to be tight only to pressure applied from the blowing engine side, and will lift and permit some flow under pressure from the opposite side. Such pressure could be set up if the furnace slipped, or if gas ignited explosively in a stove having no other relief opening. Hence, measure No. 2 must also be observed.

Rule 2. *Close all hot blast valves* except the one on which back-drafting is proceeding. This not only augments the effect of the closed cold blast valves, but also guards against vagrant gas drifting into an otherwise closed-up stove. Such drifting could occur on a prolonged shutdown, during which stoves gradually cool and therefore set up a slight suction. When the wind is again put on the furnace, the presence of such gas in the "blast" stove is an explosion hazard. This specific situation has been repeatedly demonstrated in practice.

Rule 3. *Close chimney valves* on all stoves, except the back-draft stove. By "all stoves" is meant those connected to the same chimney even though some of them may belong to another blast furnace. Several undesirable conditions can arise if the chimney valves (except on the back-draft stove) are not closed. If the gas inlet door on some other stove is also open, then an open chimney valve on that stove debilitates the draft effect upon the furnace. Moreover, the intake of cold air tends to cool the stove. If the gas inlet door is closed, then an open chimney valve puts the stove under suction from the

Figure 1 — Schematic diagram of blast system for a blast furnace, which has been prepared to illustrate the discussion. Diagram shows blast furnace blowing engine or turbo blower, stove stack and essential interconnecting piping. Location of valves is shown, but their open or closed position is not indicated.



chimney. Hot blast valves are seldom "bottle-tight," unless under substantial pressure. Consequently, an open chimney valve will be likely to induce an infiltration of vagrant back-draft gas.

As designated above, the second criterion for proper back-drafting is that the gas be disposed of safely. This calls for a recital of what should be "common law" for back-drafting:

UNBURNED BACK-DRAFT GAS IS A POTENTIAL HAZARD

The gas may all be successfully directed into a certain stove, into the breeching, and up the chimney. But if in some inadvertent manner or at some inappropriate place it meets and mixes with air, and then presently encounters a source of ignition, the very act of back-drafting, intended broadly as a safety measure, can put personnel and equipment in jeopardy. Such an appropriate place for air and gas to mingle can be, and not infrequently is, the breeching or flue between stoves and the base of the chimney. Air can come from another stove with chimney valve and gas door open; from leaks in the breeching around chimney valve settings or in the bulkhead at the end of the tunnel; from an open cold blast valve on the back-draft stove. Even the blowing off of a stove on a neighboring furnace, into a common chimney flue, while back-drafting is in process, can be a seemingly innocent and consequently insidious source of air to make an explosive mixture through contamination with unburned back-draft gas. A source of air that can almost be termed flagrant in its violation of safety, is the directing of the snort valve relief into the chimney flue. Such an arrangement has so much allure for abating the noise of the open snort that some designers have been unable to resist it, but the destruction of a stove chimney, as appears in the news from time to time, should inspire repentance and teach restraint.

A circumstance that makes the matter of back-drafting a treacherous proceeding is that frequently, but more or less inadvertently, the gas does burn wholly, or at least to an extent sufficient to render it harmless. This is by reason of air which is sucked into the bustle pipe through open boot legs, peep sights, or caps. The roar of combustion in the hot blast main while tuyeres are being changed is a familiar sound to furnace men. But, after the blow pipes are up and peep sights are closed, there is no longer an intake of air, and the back-draft gas flows on unburned. Moreover, back-drafting is sometimes conducted when there are no such openings for the incidental introduction of combustion air. Thus, back-drafting even in the most imprudent manner can often be safe, while at other times it becomes highly hazardous. So it is that improper back-drafting procedures "get by," sometimes for periods so long that such procedures become "accepted practice." Sooner or later the inevitable contingency occurs. A chimney is blown down, or a cold blast line or engine room is wrecked. Then the testimony that "we were back-drafting according to accepted practice," puts the incident, at least in its publicized version, into the category of mysterious and unexplainable. If unburned back-draft gas is a potential hazard, then the organized combustion of this gas will abate the hazard. By organized combustion is meant combustion that is continuous and reliable throughout the entire back-draft period, and in a suitable place. The logical place to burn the back-draft gas is in the combustion chamber of the back-draft stove. Combustion is secured by the observation of certain additional rules now to be added to the three listed previously:

Rule 4. *Keep the gas inlet door on the back-draft stove open continuously.* This admits air for combustion.

Rule 5. *Use the hottest stove for back-drafting.* This offers maximum opportunity for ignition.

Rule 6. *See that the back-draft gas is burning.* Usually the gas will ignite very readily, but it may not. If it does not, the hazard is re-established. The stove tender should be instructed, and should have the facilities, to kindle an effective pilot fire if need be. A few gallons of oil and a few pounds of cotton waste are less costly than a wrecked chimney, to say nothing of injury to personnel.

Some may object to opening the burner door on the back-draft stove on the plea that it cuts down the effectiveness of the draft on the furnace. It may do so. Where there is a very large gas door, it may not be necessary to open it fully; but to modify Rule 4 is to temporize the situation. It is a case where good judgment is worth a dozen rules.

Rule 7. *Do not put the back-draft stove back on blast.* The last element of back-draft gas has the same potentialities as the first. Unburned gas, met by an advancing wave of hot blast, will explode. It frequently does so at furnaces where this rule is not observed. Fortunately, this explosion is usually of the "puff" variety, only violent enough perhaps to blow broken peepsight glass into an observer's face.

Rule 8. *To discontinue back-drafting, first close the hot blast valve.* Thereafter, the burner door and the chimney valve may be closed if desired, but the interval will have permitted air to purge the stove.

WHEN TO BACK-DRAFT

It should be clearly understood that the need for back-drafting is by no means limited to the changing of tuyeres, or when dealing with other openings in the furnace. Back-drafting should be instituted whenever the blast pressure is taken completely off the furnace. This does not mean whenever the snort is open to atmosphere and closed to the furnace. The closure of the snort valve to the furnace is rarely if ever bottle-tight. In fact, at many furnaces this part of the snort is deliberately set so as not to come quite to seat. Usually, to take the blast pressure completely off the furnace, the cold blast valve on the "blast" stove is closed. Thus, Rule 1, cited earlier, becomes a reciprocal item:

Close the cold blast valve when back-drafting.

Back-draft whenever the cold blast valve is closed.

The reason for this resides in the principal purpose of back-drafting, namely, *the complete and safe disposal of residually generated gas.* This residually generated gas is in evidence when the blast pressure is completely off the furnace. If this gas is not disposed of, it will tend,

due to its pressure, to percolate into stoves, mains and breechings where its presence constitutes a hazard. Back-drafting nullifies the pressure condition, and consequently abates the hazard.

Any other situation that causes the blast pressure to be so reduced as to permit the pressure of the residually generated gas to predominate, calls for back-drafting.

ELEMENTS OF DESIGN AND CONSTRUCTION WITH REFERENCE TO BACK-DRAFTING CHIMNEY

Chimney — With the almost universal adoption of pressure burners, one of the few remaining reasons for a stove chimney of substantial height is its capacity to create back-draft suction. The requisite intensity of this suction varies with circumstances. The residually generated gas is much "wilder" when the furnace has taken water from burned bronze, than when the shut-down is merely to change tuyere sizes or clean blow-pipes. In the former case, back-drafting through a 225-ft stack may still oblige the furnace men to "fight" some fire. Most stove chimneys are 225 ft in height, some few are higher. With a low chimney, the opening of the burner door on the back-draft stove (Rule 4) could materially impair the intensity of back-draft, and hence the operator might be inclined not to open the burner door. A 175-ft stove chimney was recently destroyed during back-drafting. It is not known whether the burner door was open.

Assuming that the base of the stack is 46 ft below the tuyere level of the furnace, and assuming 0.5 in. friction loss from bustle pipe to top of chimney, the relative net effective draft at the furnace for various total heights of chimneys is approximately as follows:

Height of chimney, ft	*Net effective draft, in. H_2O*
175	0.10
200	0.20
225	0.30
250	0.40

It will be noted that the 175-ft chimney is proportionately much less effective than the 225-ft chimney. One would probably be obliged to keep the burner door shut with the shorter chimney. As a consequence, a 175-ft chimney might contribute to the hazards of back-drafting.

Almost perennially the question arises as to why not back-draft direct to the chimney through a by-pass connection from the hot blast main. The answer is simply that a stove chimney is not constructed to serve as a combustion chamber, which it would inevitably have to do. Even unburned back-draft gas is very high in temperature. Its products of combustion might easily be in excess of 2500 F. With conventional back-drafting through a stove, this heat is abstracted in the stove checkers, and the gases reach the stack at a temperature in the general vicinity of 500 F at most, a category to which the chimney is accustomed.

The usual stove chimney is not designed and constructed in anticipation of 2500 F gases. Moreover, to expose it to such heat for a period and then to return it to the 500 F routine, would subject the structure to expansion and contraction stresses which could well be highly damaging.

Stove gas inlet valves — Reference to this item of equipment is more in anticipation of a possible trend than in consideration of a present condition. Very few stoves in this country are equipped with fixed gas inlet valves. The majority employ the roll-aside type burner door. However, the fixed valve has desirable aspects, and its adaptation from foreign designs and wider use here are entirely predictable. In supplanting the burner door, one should not lose sight of the necessity to provide an air inlet to the stove combustion chamber, and means of observation as prerequisites to safe back-drafting.

Hot blast connection — The difference in elevation between the gas inlet and the hot blast connection on stoves varies widely. A random scrutiny of six sets of stoves shows a variation from 0 to 28 ft. From the standpoint of blast-heating duty, there is probably little or no objection to having the hot blast connection high up on the stove; although the gas inlet should be near the bottom so as to utilize the combustion chamber volume as fully as possible. In back-drafting, the functions of these two connections are, in a measure, reversed. The hot blast connection admits gas; the gas inlet admits air. If they are wide apart, two undesirable factors assert themselves: (1) it is difficult to ascertain whether the back-draft gas is burning, and (2) the effectual volume of the combustion chamber (above the hot blast connection) is substantially reduced, so that combustion may extend into the checkers in a manner which may be harmful.

Hot blast drop valves — In the past, many furnaces were equipped with a drop valve on the hot blast main near the bustle pipe, sometimes known as the Dyblie valve. When the blast went off, the valve opened to atmosphere, and when back-drafting proceeded, usually permitted air to be sucked into the hot blast main. As a result, the back-draft gas was provided with some air for combustion. The purpose was worthy, but the application was not without objection. The valve was in a location not readily observable to those busy about the furnace. If it failed to open, none were the wiser, but a hazard had been set up. If it failed to close when the wind came on again, a blast of air was turned loose under the cast house roof which brought down vast clouds of dust, and occasionally pieces of material such as sheet iron, planks, etc. This inelegant behavior did not encourage the maintaining of the valve in functional condition. In fact, it led in more than one instance to the deliberate lashing or blocking of the valve in the closed position. Gradually the Dyblie valve disappeared. There are furnace men who have grown up in blissful ignorance of its prior existence and purpose. In the course of its passing, it became a rule at some furnaces that the stove tender always arrange to knock open a few peep-sights during back-drafting. This is a well-intentioned measure for admitting combustion air, but it takes the stove tender outside of his domain. He back-drafts first, and in due course gets around to opening the peep-sights. Then he has to close them again in plenty of time to stand by his stoves, for resumption of operation. Thus there are periods in which back-draft gas is not burning. On a short stop, the futility of the open peep-sight rule is obvious. Neither the drop valve

nor the open peep-sight rule is a substitute for opening the gas door on the back-draft stove.

Snort valve blow-off valves — The snort valve relief positively should not discharge into the chimney flue. This has been previously discussed, but it is deemed important enough to bear repetition here.

The discharge of blow-off valves into the chimney flue is to be tolerated only if the flue is not shared with a neighboring furnace. The common chimney flue is frequently encountered, however, so that usually the blow-off is best directed to the outside air.

Mixer valves — Every blast furnace is provided with a blast mixer system. It consists basically of a pipe, with valves, connecting the cold blast main directly with the hot blast main, thus by-passing the stoves. Its purpose is to permit regulation of the temperature of the hot blast going to the furnace by introducing a controlled quantity of cold blast.

Since the mixer line constitutes a direct connection between the furnace and the cold blast system, shut-off means of more or less elaborate nature are provided with the intention of preventing gas from finding its way into the cold blast system and ultimately, perhaps, to the blowing engines. Explosions occurring in the cold blast system invariably cast suspicion upon the mixer line, and it is true that the cause could reside either in the neglect or in the inadequacy of the shut-off measures. These measures are found in considerable variety. As a rule, they consist of two elements arranged in series, one manually controlled, and one which is to function automatically. The manual element may be a gate valve and it is generally designated as the "mixer valve." It may be motor-operated. The automatic element is usually some form of drop valve. Usually the mixer valve is placed first in the direction of flow of cold blast so that its closure assures of zero pressure on the drop valve which otherwise might not close.

It is a well-established maxim that the stove tender close the mixer valve before or when the wind is taken off the furnace. Human frailty as well as mechanical defects may defeat the intent, however, and then dependence is placed upon the drop valve. This piece of equipment is usually just as reliable as other equipment about a blast furnace, and is subject to the same shortcomings. Be that as it may, back-drafting properly conducted removes the contingency that may result from failure to close off the mixer line. Back-drafting draws the flow of gas away from the mixer line and toward the combustion side of the back-draft stove. This is not to say that back-drafting relieves the stovetender of responsibility for closing his mixer valve, but it can be comfortable insurance in case he fails to do so.

SUMMARY

The purpose of back-drafting is the complete and safe disposal of residually generated gas on a shut-down blast furnace, which gas under its own pressure would otherwise issue dangerously from openings, or would percolate into the blast system to constitute an explosion hazard.

All stove valves should be shut when the wind is completely off the furnace except the hot blast valve, chimney valves, and burner door on the back-draft stove.

The back-draft gas should be burned in the back-draft stove.

Back-drafting should be conducted whenever the wind is completely off the furnace.

Back-drafting can be made hazardous by conducting it improperly; principally by failure to burn the gas. Certain design and construction features can contribute to the hazards of back-drafting; e.g., inadequate chimney height, snort valve discharging into the chimney flue, etc.

Back-drafting properly conducted can be insurance in case of some human and mechanical failures.

In a very broad sense, back-drafting is a means for permitting the wind to be taken completely off the blast furnace in a safe manner.

DISCUSSION

PRESENTED BY

H. O. JOHNSON, Special Assignment, American Steel & Wire Co., Cleveland, Ohio

H. O. Johnson: I would like to relate an experience we had at Donora No. 1 furnace shortly after a change in design of our stoves from the old type large checker, average opening about 12 in., to the small 3¾-in. basket weave checker.

The furnace had been shut down for a tuyere change for about 12 minutes. The back-drafting was done in the conventional manner, using the stove closest to the furnace; the stove was closed tight, except from the chimney valve which was open to the stack serving seven stoves for our two furnaces; all the burners were pulled back, bleeders were open, steam in dust catchers, mixer valve closed tight, all goggle valves closed, air inlet valves on all stoves closed and the hot blast valve in the open position.

When the blast was put back on, a terrific explosion occurred in the flue, dislodging a brick bulkhead under the stove stack. No damage was done due to the force of the explosion having spent itself through the bulkhead flue leading out to the atmosphere.

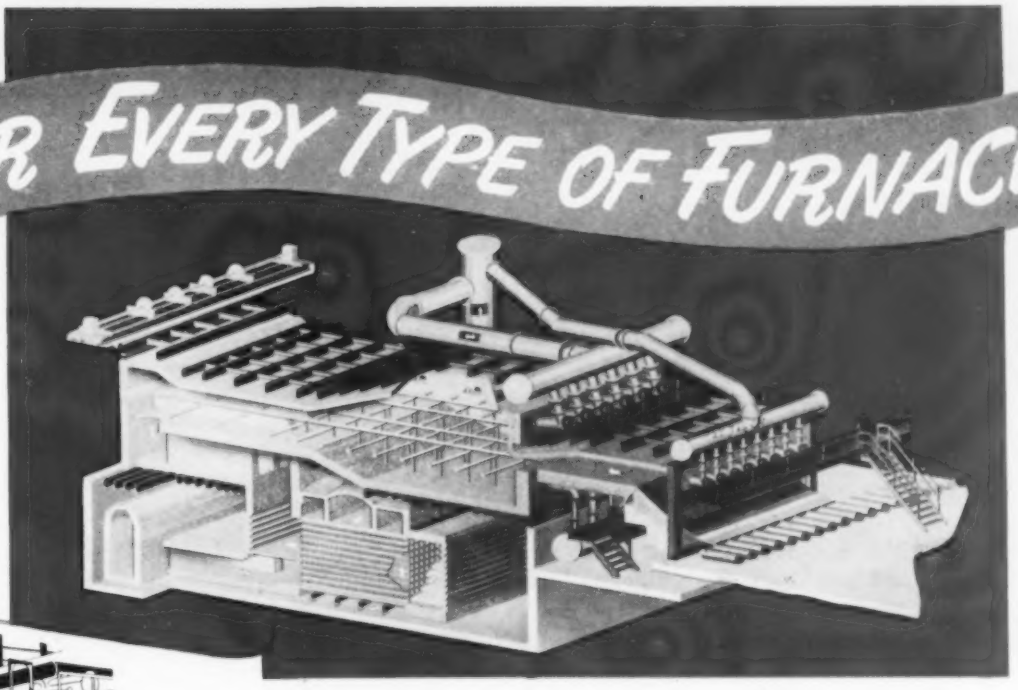
Following this experience, the practice of burning the gas by leaving the burner door open was started. This, however, had its disadvantages due to the high concentration of carbon monoxide in the gas when back-drafting. The heat became so intense that it caused a slagging of the brick work in the hot blast valve chamber and the lower part of the combustion chamber. To prevent this slagging the practice of changing the stoves on back-draft was started during a long stop.

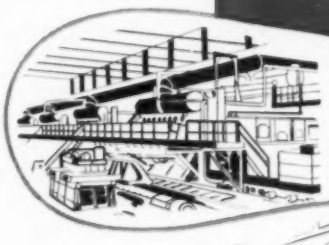
About two months later we had another explosion of a minor nature and decided to purge the flues each time the furnace was shut down.

Two 1¼-in. steam jets were installed in the flues from each furnace. The responsibility of inspecting, maintaining and operating these systems was assigned to the turn pipefitter. Since this installation, no further explosions have occurred.

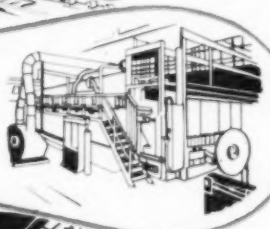
It is our belief that the change from the large checkers with low resistance, to the small checkers with higher resistance, required more draft than the stack would draw.

FOR EVERY TYPE OF FURNACE

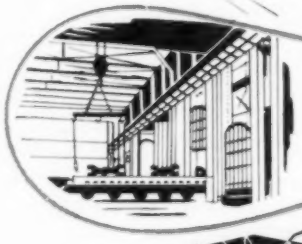




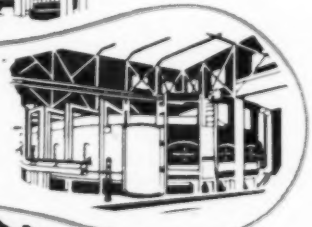
SLAB, BLOOM, BILLET, BAR HEATING FURNACES



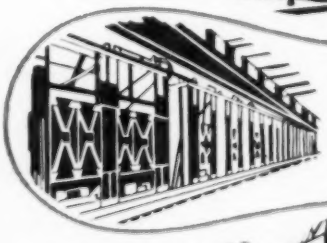
CONTINUOUS PIPE ANNEALING FURNACES



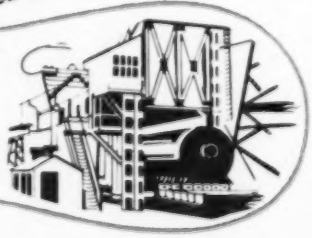
CAR BOTTOM TYPE HEAT TREATING FURNACES



ROTARY HEARTH, BLOOM AND BILLET HEATING FURNACES



BOX ANNEALING FURNACES



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Venezuelan Ore Reaches the States

. . . . a new era in ore supplies has been inaugurated with the arrival of iron ore from Venezuela for American steel plants . . . .

▲ THE arrival of the S.S. Bethore with the first cargo of iron ore from Venezuela to Bethlehem Steel Co.'s plant at Sparrows Point, Md., marks the culmination of a period of exploration and development which extends over more than fifteen years. When full production is reached, the deposit of Iron Mines Co. of Venezuela, at El Pao, State of Bolivar, is scheduled to yield about 3,000,000 tons of iron ore annually. It is also possible, without material changes in layout and equipment, to increase the mine production to 5,000,000 tons a year.

The new supply will supplement iron ore shipments from Chile and other foreign sources and will help to provide the large additional tonnage of ore needed as a result of the current 2,600,000-ton increase in Bethlehem's annual steel-making capacity. Second largest producer in the country, the company now has an annual ingot capacity of 16,000,000 tons.

The preparatory work required in bringing this new mine into production, included the construction of a river loading station and a deep-water port, and the building of a fleet of shallow-draft vessels, tugs and barges. Three new communities have been created in the wilderness, a railroad and a highway have been pushed through the jungle, and several hundred miles of river have been sounded, charted, and marked with aids to navigation.

Discovery of the El Pao deposit is credited to a native prospector who, in 1926, found a large outcrop of rich iron ore on the summit of a hill known as El Florero. At that time El Pao was nothing but undeveloped jungle, with a few scattered huts, about 30 miles south of San Felix, a village of around five hundred souls situated near the confluence of the Caroni and Orinoco Rivers.

After some preliminary exploratory work Bethlehem Steel Co. acquired the concessions in 1933 and organized the Iron Mines Co. of Venezuela to develop and operate them. At first 22 concessions were acquired. Six of these were later relinquished, leaving the company with a total of 16 concessions covering an area of nearly 20,000 acres.

A general survey of the property was started in 1937. This included exploration and mapping, preparation of engineering plans and general layouts for camps, shops, and a railroad and a highway between the mine and the present port of Palua on the Orinoco River.

A plan was adopted which involved shipping of the ore by rail from the mine at El Pao to Palua on the Orinoco River, for storage or loading into shallow draft vessels or barges. These take the ore down the river to the transfer station at Puerto de Hierro, a distance of about 230 miles. At Puerto de Hierro the ore is transferred to the stock pile for loading into specially designed ore carrying vessels for shipment to the United States. The vessels are loaded at the rate of 3000 tons per hour.

Actual construction work was started in February 1941; however, lack of personnel and materials brought the work to a virtual standstill during and immediately following the war years. Without this the work would probably have been finished in five years instead of taking nearly ten.

In February 1947, the company acquired two properties on the Gulf of Paria, known as the Valley of Jamaica and the Valley of Carenero, to be used as site for a transfer station appropriately named Puerto de Hierro, or "Iron Port." Construction here was started in May of the same year and completed in July 1950.

The first major step in the building program was the establishment of a construction camp at Palua, with docking accommodations for vessels bringing in machinery and supplies, and adequate warehouse and storage facilities. A 50-ton stiff-leg derrick was erected on the river bank, for use in unloading cargo.

With the completion of a 30-mile two-lane gravel road from Palua to El Pao, early in 1944, work on the mining camp could proceed. Construction of the single-track railroad to the mine was also started at the same time, and the last spike was driven on June 1, 1950.

The total length of the railroad is

A 4-cu yd electric shovel loads the broken iron ore into 30-ton capacity trucks at the El Pao Mine.

38.7 miles, of which 34.8 miles is main-line track. It climbs about 1600 ft as it winds its way up to the mine.

Of the total trackage, 21 miles is curved and super elevated; maximum curve is 11 degrees U. S. standard, and maximum grade 2 per cent, compensated for curvature. There are six short-span steel-girder bridges, five arch culverts and twelve box culverts. Five sidings are provided for passing.

Over 1,500,000 cu yds of earth and rock had to be moved in the construction of the railroad. Two quarries with a crushing plant were opened, one at each end, to supply granite ballast for the road bed. Imported creosoted pine ties were found to be the most economical and satisfactory for service in the tropics. The track is U. S. standard gage, with 100-lb rails.

The main-line haulage equipment consists of three 130-ton, 1500-hp diesel-electric locomotives with dynamic braking; a hundred 70-ton bottom-dump ore cars and miscellaneous flat cars, box cars, and tank cars.

Tug and loaded barge at Palua, on the Orinoco River. The large steel structure extending out over the river is the cantilever which carries the belt conveyor used in loading the barges. In the background is an ore bridge under which is storage space for 800,000 tons of ore.

The ore is a hard, massive hematite which will range from 63 to 66 per cent iron, as shipped. It is of a type that may be used either in blast furnaces, or open hearths. The main deposit now being mined is a bowl-shaped formation about 2600 ft long and 1700 ft wide, on top of a hill rising several hundred feet above the surrounding country. The center of the bowl-like formation is filled with an overburden consisting mainly of clay, but with some igneous material; this ranges up to 425 ft in thickness and must be stripped before the ore body can be mined out. The ore body itself varies from a few feet to approximately 400 ft in thickness.

There are other exposed ore bodies within the concessions which will be mined later, but sufficient diamond drilling has not yet been completed to determine their size.

The mining method adopted is one of slicing off the top of the hill in 13-meter high benches by standard open-pit methods. Eventually, due to the shape of the ore body, a pit will be excavated within the hill. Actual mining operations were started in August 1950 and are now being carried out on the two upper benches where the ore is exposed at the surface, with no overburden to remove. The program for the stripping of overburden will begin shortly and will progress with the mining of the various levels. Present estimates indicate that 1 cubic yard of overburden will have to be removed for every 4.2 tons of ore mined.

Primary drilling in the ore is done with cat-mounted electric churn drills with 9-in. diam bits. The upper portion of the ore body now being mined is badly fractured, a condition which, combined with the extreme hardness of the ore, presents a very difficult drilling problem.

Secondary drilling is presently being done with pneumatic wagon drills and jack hammers with "one use" and tungsten carbide insert detachable bits. A steel drop ball will also be used for secondary breakage where practicable.

At present all blasting is done with 60 per cent straight gelatin dynamite detonated with instantaneous detonating fuse and electric blasting caps.

The ore is drawn from the ore pocket through chute gates in the roof of the tunnel and delivered to a 48-in. rubber belt conveyor by three travelling roll-type feeders.

Other types of explosives are being tried out to determine the type most economical and efficient under prevailing conditions.

Ore and overburden are handled by four electric shovels with 4 cu yd dippers and Ward Leonard control. The ore is loaded into ten 30-ton, side-dump semi-trailers hauled by 200-hp diesel-engine powered tractor trucks. The heavily loaded trucks travel about 1 mile down an 8 per cent grade to the crushing plant. A special hydraulic retarding unit supplements the regular brakes on the down hill haul. The trucks are dumped at the crusher by a fixed overhead crane which permits control of the rate of feed to the crusher.

Primary crushing is done in a 54 x 84-in. Blake-type jaw crusher powered by a 350-hp electric motor through V-belt drive. Set to crush to 6-in., the crusher has a capacity of 900 tons of ore per hour.

The jaw crusher discharges directly onto a 42-in. rubber belt conveyor, 179 ft long, running at 370 ft per min. and delivering the ore to a 2⅜-in. grizzly at the secondary crushers. Oversize from the grizzly flows into two 5 ft 6 in. gyratory crushers, each with a capacity of 440 tons per hour and set to crush to 2½ in., or bypasses the gyratories as open-hearth lump.

Gyratory discharge and the undersize from the grizzly are combined on a 42-in. belt conveyor, 426 ft long, running at 370 fpm and discharging onto a 2⅜ in. grizzly on top of the ore-loading bin at the rail head. This bin, a large steel structure, has a capacity of 4000 tons and is divided into three compartments to permit

Trainload of ore leaving El Pao mine for Palua on the Orinoco River where the ore will be loaded into river craft for shipment to tidewater. Thirty to thirty-three 70-ton cars make up a train.

separate handling of blast furnace ore and open hearth lump ore.

Ore is drawn from the bottom of the bin through six air-cylinder operated gates into railroad cars on a double track under the bin. A 70-ton car can be loaded in about one min.

Normally a train is made up of 30 to 33 cars, drawn by one locomotive, with 36 cars the maximum. With an annual production of 3,000,000 tons of ore four trains will be run from the mine to Palua every working day. Due to the steep down-grades, the heavily loaded trains must travel at moderate speed, negotiating the trip to Palua in a little over two hrs.

At the river port of Palua the loaded trains are run onto a plate-girder steel trestle over a 550 ft long, 43 ft deep pocket excavated in the solid rock parallel to the Orinoco River bank. Ore from the bottom-dump cars is discharged into the pocket which has a live storage capacity of 27,500 tons with an extra 16,500 tons dead-storage capacity.

An additional 800,000 tons of ore can be stocked under a 13-ton ore bridge which overhangs the ore pocket and operates on tracks parallel with it. The bridge has a span of 320 ft and 146 ft and 95 ft cantilevers.

Underneath the storage pocket is a 660-ft reinforced concrete tunnel with twenty 4 x 4 ft air-operated chute gates in the roof, through which the ore is drawn from the pocket through three roll-type feeders and delivered to a 48-in. rubber belt conveyor, 617 ft long, which travels through the tunnel at a speed of 450 ft per minute.

To prevent surges of ore from flooding the belt, the feeders are interlocked with the gate mechanism by electric relays in such a manner that it is impossible to open a gate unless a feeder is in the correct position underneath, with the drum revolving.

The tunnel conveyor discharges the ore to a second 48-in. belt, 537 ft long, built at right angle to the ore pocket. Conveyor No. 2 travels at 450 fpm onto a 416-ft long steel loading structure which cantilevers out over the Orinoco River.

Directly underneath the second conveyor and parallel with it, is a 141-ft long 48-in. shuttle conveyor, operating at 455 fpm, which discharges the ore through a telescoping steel chute directly into the vessels moored below. This conveyor has a travel of 64 ft, sufficient for proper trimming of the vessels being loaded.

This method of loading was made necessary by the large seasonal variation in the water level of the Orinoco River, nearly 43 ft at Palua, which makes it impracticable to load the vessels from an ordinary wharf structure.

Five 4500-ton barges with 14-ft loaded draft and one twin-screw river vessel of 8500-ton capacity at maximum draft, the "Punta Aramaya," are used to transport the ore from Palua to tidewater. A second river vessel, the "Punta Morocoto," will be in service by April of this year and a third vessel has been authorized.

To provide a mooring platform with the necessary equipment for shifting the vessels during loading, a floating dock has been developed. This dock is 480 ft long and is made up from six articulated 80 x 20 ft sections pinned together. Each section is constructed of 24-in. wide-flange beams and floats on four steel pontoons, 20 x 7½ ft, 4½ ft deep, any of which may be removed for maintenance and replaced without interference with the operation of the dock.

The dock is held in position by six anchor chains. In order to provide sufficient depth of water over the chains, these are fastened a considerable distance back of the fender line to anchor sections pinned to the dock. A chain to the shore at each end and two diagonal chains for securing the dock longitudinally complete the anchorages. The river anchors were dragged and the chain prestressed to a 50-ton pull, adjusted to proper position, and fastened permanently to the dock.

This arrangement gives the dock full freedom to move up and down with the rise and fall of the river. It is remarkably stable, requires no adjustment, has excellent shock-absorbing properties, is inexpensive to construct, and may be painted and maintained without interruption in service.

The barges, which operate only during the season of high water, from April to November, are towed to Puerto de Hierro by 1300-hp ocean-going tugs, the "Patao" and the "Capure." They travel via Caño Manamo past Pedernales and across the Gulf of Paria, a distance of 230 miles.

Due to their greater draft, the "Punta Aramaya" and her sister ships must travel the 395-mile route through the main channel of the Orinoco—the Boca Grande—and up the coast. During the season of high water they may return empty to Palua by the shorter Pedernales route.

Normally the barges will make the round trip in three days, as will the larger vessels when they can use the shorter route back to Palua.

Puerto de Hierro waterfront, with an ore barge being unloaded. At the center of the picture is the trestle on which the unloading conveyor travels ashore from the pier to the storage pocket.

On the right is shown the unloader conveyor at Puerto de Hierro which carries the ore from the pier to the stockpile over the loading conveyor tunnel. At the left is the loading conveyor emerging from the tunnel which takes the ore from stock to load the ocean going vessels on the east side of the pier.

As a preliminary to shipping, the company surveyed and sounded both branches of the river and installed over a hundred beacons and buoys to aid navigation.

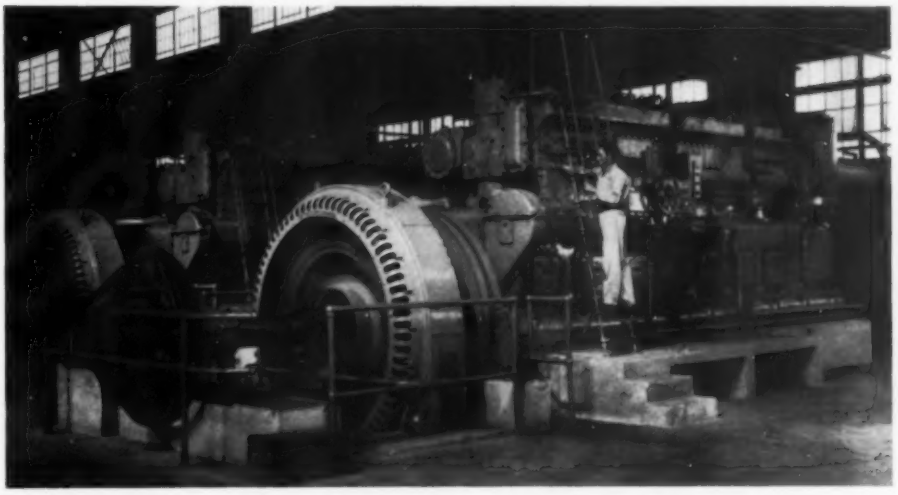
Selections of Puerto de Hierro as terminus for the river craft was made after a thorough search along the coast for a suitable location for docking and loading the 26,000 net ton ore carriers, with adequate space for ore storage and the extensive shore installations required to maintain the port.

Barges arriving at Puerto de Hierro are unloaded by three traveling towers with 8-ton grab buckets and discharged onto a 48-in. rubber belt.

Due to foundation conditions, it was decided to locate the heavy stock pile far enough inland to guarantee stability. Such an arrangement required a pier where barges and river vessels could be unloaded and where ocean-going vessels could be loaded at the same time if necessary.

A flexible type pier of steel construction, resting on steel H-piles, was found best suited for supporting the heavy, concentrated loads of the loading and unloading towers.

Ground borings showed a sand bottom under the mud in the bay, and load tests on piling indicated that loads in excess of 100 tons per pile could be adopted in the pier design. Before construction on the pier was started, the bay was dredged to a maximum depth of 42 ft below low water.



Diesel-electric power station at El Pao. In addition to three 980-kw generators of the type shown, the station has one 250-kw and one 66-kw unit.

The main pier structure and ramp is 785 ft long and 80 ft wide, and is supported on 239 14BP 102-lb steel H-piles. The superstructure consists of heavy steel framing welded to the piles and a deck of continuous reinforced concrete integral with the steel framing. This makes the whole pier act as a monolithic structure combining great strength and flexibility.

A 150-ft approach of similar construction provides two truck lanes for access to the pier. Three 30-ft diameter circular dolphins made of steel sheet piling keep the ships in proper channel and protect the pier from head-on impact.

Barges and river steamers are placed end to end along the west side of the pier and unloaded by three traveling rope unloading towers with 8-ton grab buckets. The towers, which have an average combined capacity of about 1200 tons per hour, discharge the ore onto a 48-in. rubber belt, totaling 1852 ft in length, in two flights, and traveling at 500 fpm. The conveyor leads from the pier over a trestle where the ore is discharged by a traveling-boom tripper onto a storage pile over a loading conveyor tunnel. The storage pile has 80,000 tons live capacity. An additional 1,200,000 tons may be stocked in an adjacent area under a 13-ton ore bridge with 320-ft span.

Mayari R high-strength steel was used in the construction of the unloaders, in order to decrease their weight. The high corrosion resistance of this steel was also a contributing factor in its selection. Each tower weighs approximately 400 tons.

Ore is drawn from storage into a 710-ft long concrete tunnel, similar to that at Palua, through 18 chute gates. Three roll feeders place the ore on a 992-ft, 48-in. belt traveling at 500 fpm, and discharging onto a 48-in. pier loading conveyor, 811 ft long. This passes through a traveling-boom tower which loads the ore into the holds of the ocean-going ore vessels berthed on the east side of the pier.

It requires about 10 hours to load the 26,000 net ton vessels which make the 1950-mile journey to Sparrows Point, and back, in about 13 days.

Electric power for El Pao, Palua and Puerto de Hierro is generated at 2400 volts and 60 cycles in three separate diesel-electric power stations.

Workers' village at Puerto de Hierro, looking toward the Gulf of Paria. In background are pier, conveyors and ore bridge. Large buildings in center are machine shop and warehouse.

The El Pao station has three 980-kw generators and two smaller units of 250-kw and 66-kw capacity, respectively. Palua has three 250-kw and one 66-kw generators, as well as a 500-kw d-c generator which supplies power for the ore bridge. Four 980-kw generators, supplemented by a 250-kw and a 66-kw unit produce power at Puerto de Hierro. D-c power for the ore bridge is supplied by an ignitron rectifier. Electric power for lighting and similar uses is supplied by suitable transformers.

Compressed air for the mine is produced in two 1400 cu ft per min diesel engine driven compressors.

During the peak of construction the company had nearly 1600 men working in the three camps, while about 800 additional were employed by an outside contractor. Today, with all major construction projects completed, the force has dropped to a little over 1000 men.

The problem of providing housing and other facilities for this number of men in completely undeveloped areas was one of major proportions. The first shelters were necessarily improvised and rather primitive. Today, however, the three communities offer adequate living quarters for all.

Two family houses are provided for workmen, and single dwellings for foremen, office workers and the staff. Practically all houses are one-story, of a construction adapted to the tropical climate, cool, fully screened, and termite proof. All have electric light, modern plumbing, and sewer connection. The villages are laid out with wide, well-lighted, hard-surfaced streets.

Water of excellent quality is furnished in sufficient quantity to satisfy the need of any community of equal size. El Pao gets its supply from the Caroni River, pumped through a 23-mile, 8-in. pipe line to a reservoir of 11,000,000 gal capacity. A local spring also feeds the reservoir. Palua draws water from the Orinoco, and Puerto de Hierro from a dammed-up mountain stream 3 miles away. All water passes through modern treatment plants before it is distributed.

A sewage treatment plant with digesters, filters, and provisions for disposal of sludges and chlorinated effluent is being operated at El Pao.

Communication with the outside world is mainly by airplane. The company has built an airfield at San Felix, 2½ miles from Palua, which it maintains for daily use by commercial airlines. Puerto de Hierro has daily connections by means of company launches, free to all, with nearby Guiria and its adjoining airfield.

Plan to attend!

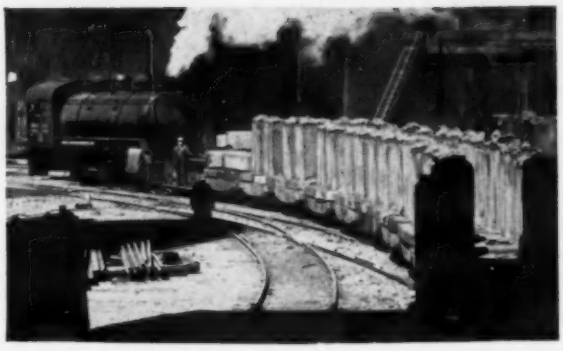
Annual Convention

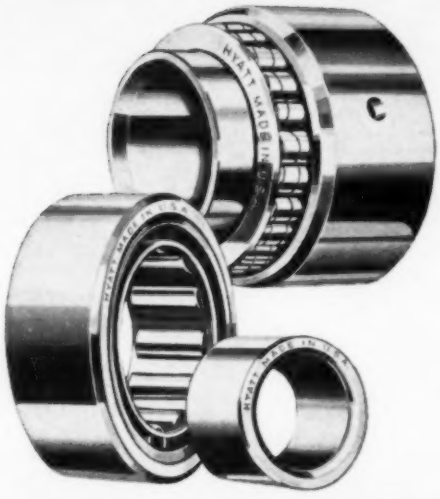
Association of Iron and Steel Engineers

October 1, 2, 3 and 4, 1951

Hotel Sherman

Chicago, Illinois





Taking Shock Loads and High Temperatures in Stride

Sudden shock loads and abnormal temperatures are the steady diet for bearings in steel mill equipment.

In National Steel Corporation's plant at Ecorse, Michigan, The Great Lakes Steel Corporation, Hyatt Bearings are installed in the table rollers, feed rollers, screw down and manipulators on the Blooming Mill and on the tables, guides, strippers and rotary flying shears of the Hot Strip Mill. On ingot cars, too, the same day in and day out dependable performance of Hyatts justifies their selection.

For new equipment or change-overs always specify Hyatts, the preferred bearings for steel mill applications. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

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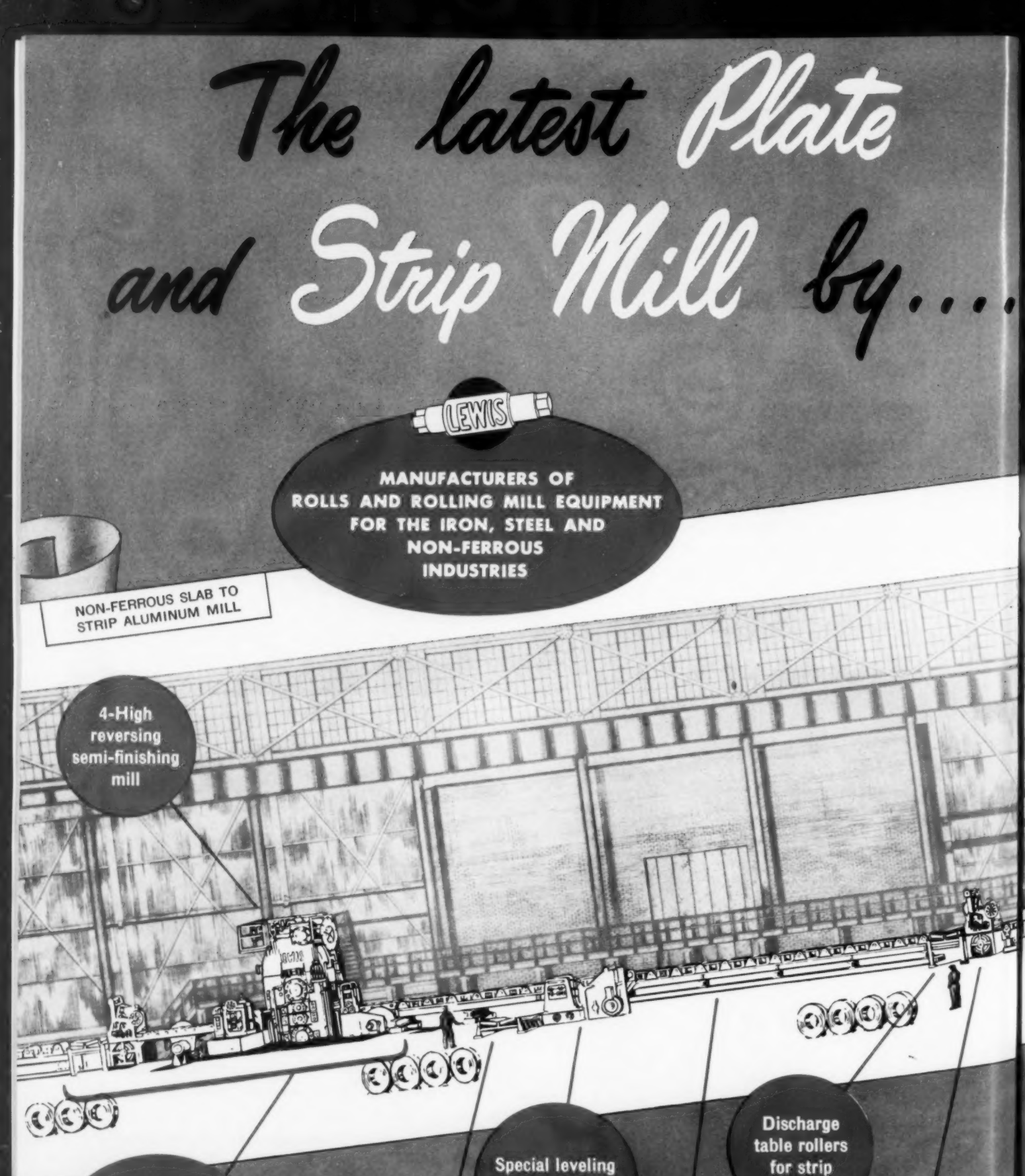
MANUFACTURERS OF ROLLS AND ROLLING MILL EQUIPMENT FOR THE IRON, STEEL AND NON-FERROUS INDUSTRIES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Intermediate table for plate
Discharge table rollers for strip
Retractable strip up-coiler

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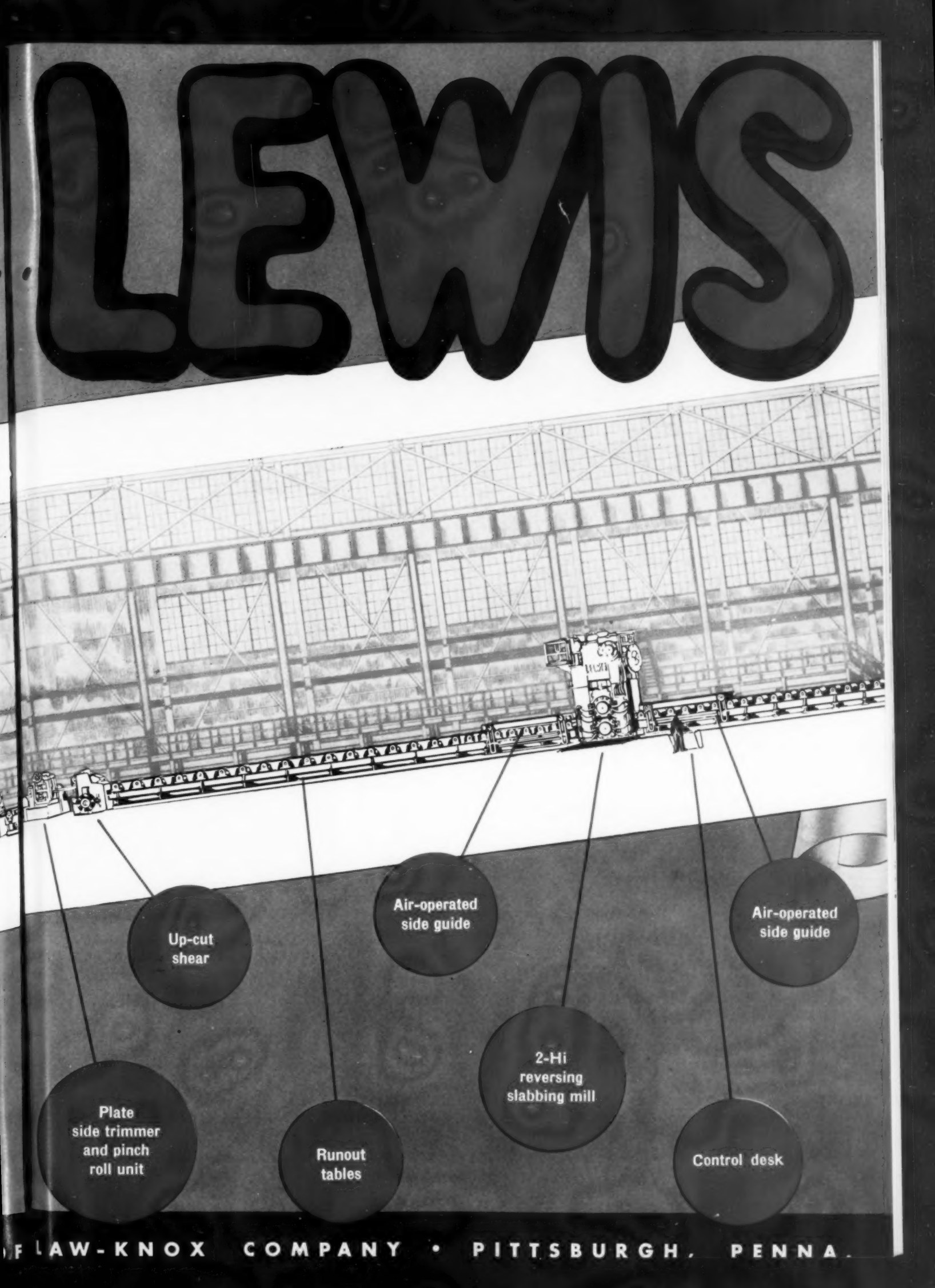


FLAW-KNOX COMPANY • PITTSBURGH, PENNA.

This New Controller Says "Hurry Up, Furnace!"

With production reaching toward all-time highs, this new P.A.T. 50 Control already is helping many key plants increase the output of their furnaces. Here's why:

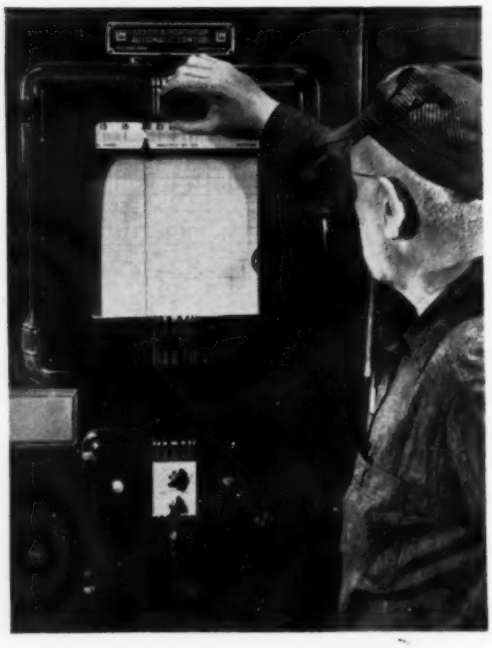
This Control has something that's brand new in proportional, electric controllers. Called "rate action," this feature enables the Controller to act on the *speed* of swings in furnace load, as well as on their size and on the length of time they persist. Thus, if temperature changes gently, it is gently nudged back into line. But if it starts off vigorously—as when the furnace door is opened—P.A.T. 50 reacts vigorously. Then, when the change has been headed off, the Controller starts to back away. But "putting on the brakes" it brings temperature in line smoothly and rapidly.

Thus, "Rate Action" increases production because it reduces the length of time a furnace is off temperature.

Also, Proportioning and Reset Actions are more responsive than before. These two components stop the normal temperature swings which are started by changes in the size and permanence of the furnace load. Even without rate action, these increases would enable P.A.T. 50 to do a better-than-ever job. With rate action, results are superior to any previous electric control.

The News is in the Control Unit at bottom of panel shown at right. Earlier installations can be converted to P.A.T. 50 by replacing the Unit and making slight changes in the Controller.

For details, contact our nearest office, or write us at 4942 Stenton Ave., Philadelphia 44, Pa.



THESE furnaces and controllers are part of the slab-heating equipment with which The Timken Roller Bearing Company, Canton, O., conditions high-alloy steels for rolling. The Timken Company has used many earlier L&N Controllers. They find P.A.T. 50 is a further step forward, not only in guarding quality, but also in increasing production by shortening the off-temperature time.

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

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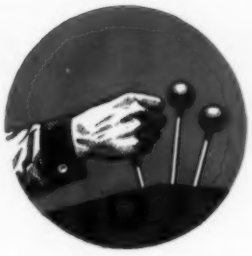

A LIGHT PULL AND YOU GO!

High power ability does it . . . the instant surge of power you get in a battery-electric truck that's Exide-Ironclad equipped. And it's finger-tip-control power . . . meets *all* demands in *stop-and-go, lift-and-shift* operations . . . plus split-second handling, easy maneuvering, accurate spotting. Exide-Ironclad Batteries also give you:

ROUND-THE-CLOCK PERFORMANCE—no mechanical troubles, no unscheduled down time.

UNIFORM SPEED straight through to end of shift.

LOW OPERATING COSTS—on the average of 4c an hour for power . . . batteries absorb a very high percentage of charging current.

LOW MAINTENANCE COSTS—seldom more than 15 cents per shift.

EXCEPTIONALLY LONG LIFE—proved on more than 100,000 heavy-duty jobs.

INHERENT SAFETY—freedom from the hazards of fire, fumes, noise and uncleanliness.

There are Exide-Ironclad Batteries for every size and make of battery electric truck.

Write for your FREE copy of the new Exide-Ironclad Battery Motive-Power Catalog, Form 5161.

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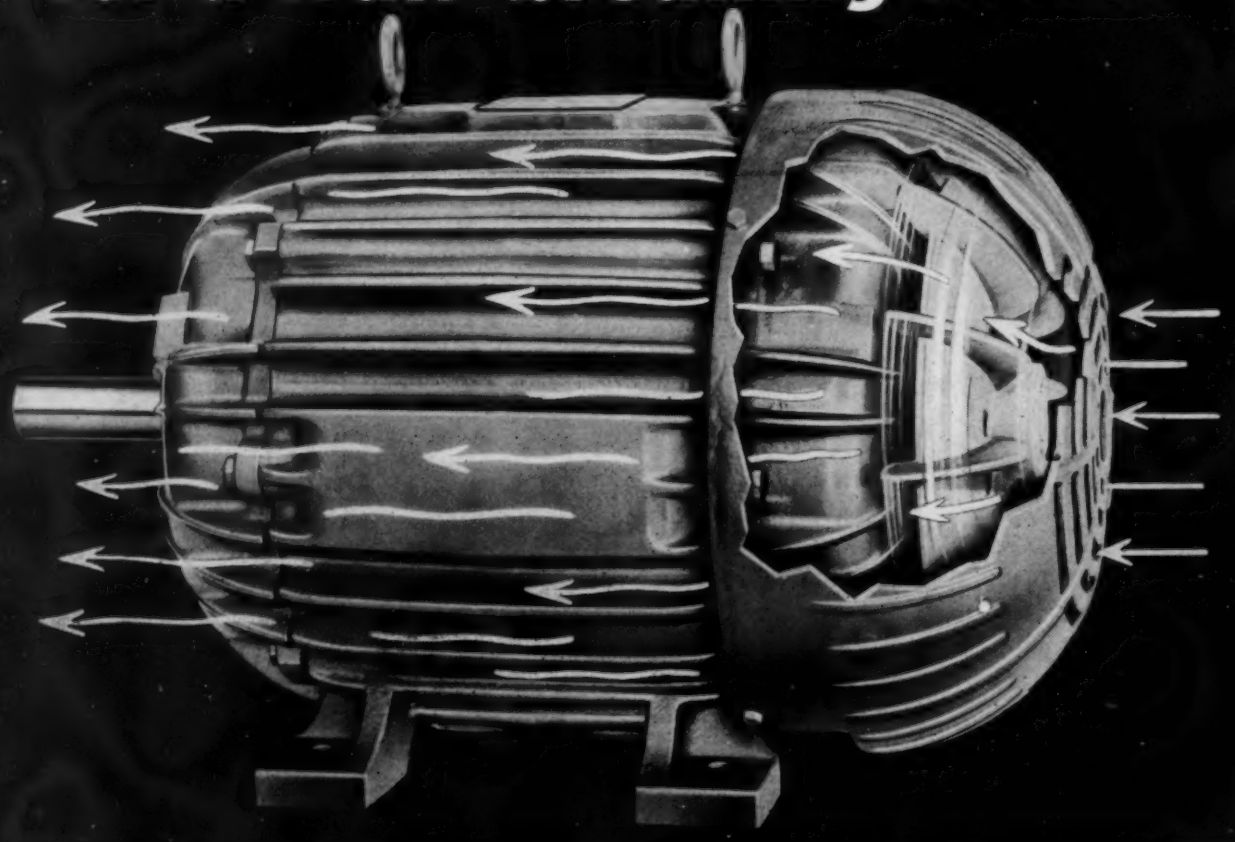
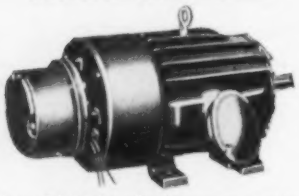
TENTH ANNIVERSARY
for a trail-breaking motor



THE ELLIOTT CROCKER-WHEELER *Sealedpower* MOTOR

SEALEDPOWER BRAKE MOTORS



The C-W Sealedpower motor is available equipped with the newly designed C-W Brake, providing increased brake capacity without increased bulk.

The Elliott C-W Sealedpower motor is available also in explosion-proof construction. Bulletin SL-300-5 covers this type. Copy on request.

Crocker-Wheeler motors range from 1 to 200 hp. Larger Elliott motors and generators are built by the Ridgway Division in Ridgway, Pa.

TEN YEARS AGO the C-W "Sealedpower" motor, with its unique cooling and self-cleaning system, made its bow to American industry. Its immediate and continued popularity has put thousands into successful service.

Completely enclosed, there's no way for dirt, dust, moisture or fumes to get in. But there's an easy out for heat—by way of the 150% increased radiating surface of the many radial fins, plus the fan-driven air blast directed along and around the fins and frame. It cleans itself, too—the air blast gives dirt and dust the quick brush-off.

WAY AHEAD OF ITS TIME ten years ago, the C-W Sealedpower Motor with further refinements is still ahead, and is the ideal motor for any service within its capacity range. Write today for Sealedpower Bulletin. Address your request to Elliott Co., Dept. IS, Jeannette, Pa.

ELLIOTT COMPANY-Crocker-Wheeler Division, Ampere, N. J.

BRANCH OFFICES AND REPRESENTATIVES IN PRINCIPAL CITIES. CW-27

ELLIOTT *Approved* SERVICE SHOPS COVER THE COUNTRY.

GENERAL OFFICES & MAIN PLANT—JEANNETTE, PA.

You're a step ahead with **ELLIOTT**

What's New?

A NEW, SAFE "FULLY REGULATED" A. C. CRANE HOIST CONTROL

This Cleveland Crane and Engineering Company crane in a midwest automotive plant is one of many A.C. Cranes operating successfully with the new CLARK Bulletin 9235 Crane Hoist Control.

This new CLARK design safely eliminates the mechanical load brake. Hoists handling widely-varying loads get accurate speed response.

- The motor speed, while lowering, is controlled by dynamic braking.
- Loads can be spotted accurately with the slow speed available on point 1 of the Master Switch.
- Three other distinct high-speed Master Switch points provide rapid hoist and lowering with loads, and the 5th point power drives the empty hook.

Mill-Type Bulletin 7700 Contactors, controlled by Bulletin 7313 VARI-TIME RELAYS, giving time-controlled acceleration, are used in both hoist and lowering circuits.

Bulletin 9235
A.C. Crane Hoist
Control

Motor damage by rapid reversals from hoist to lowering, and vice-versa, is eliminated in this new, *safe* control system.

Ask for descriptive Bulletin 9235

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HAZEN METALLIC RECUPERATORS

HAVE GIVEN

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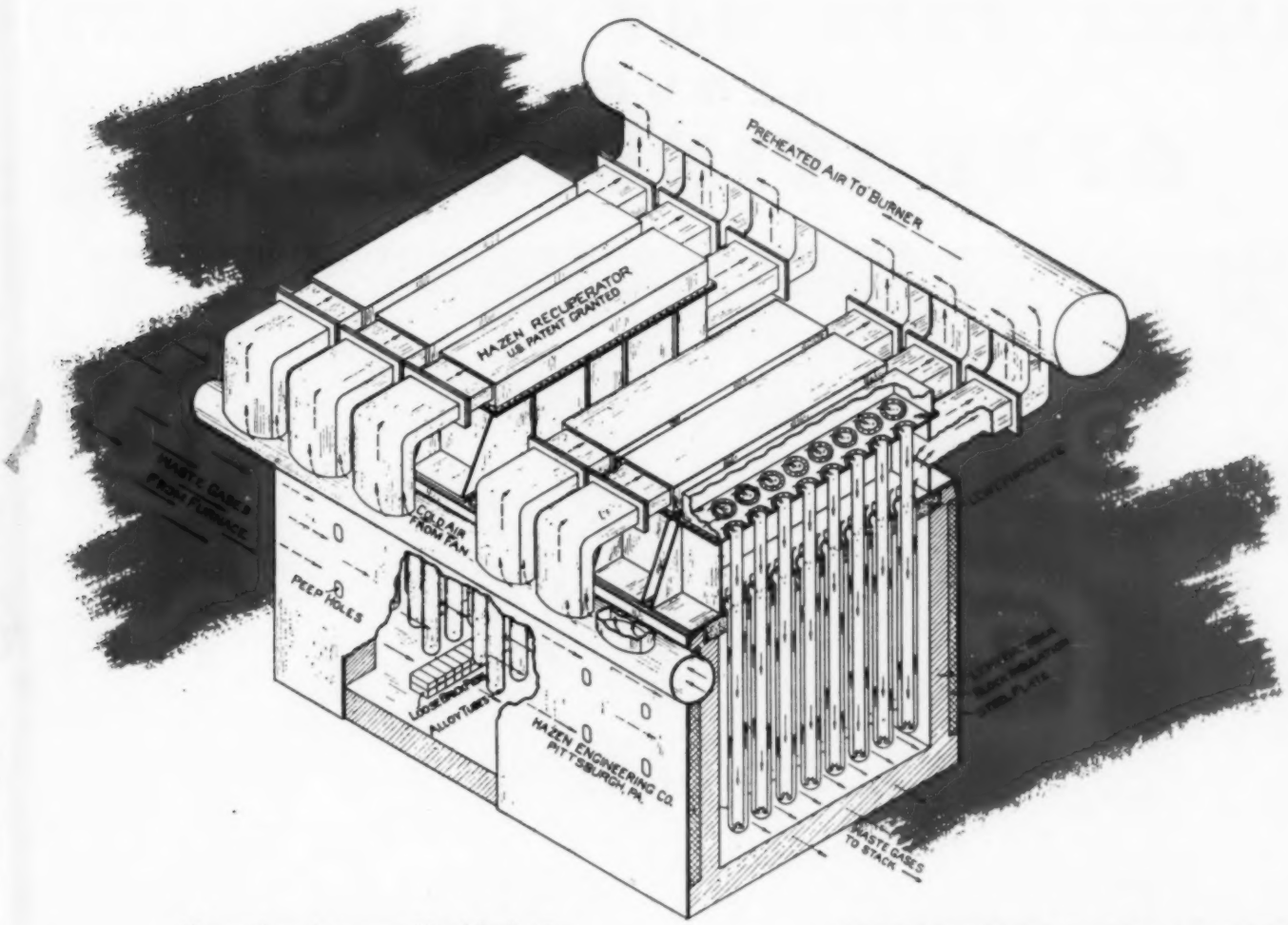
A RECUPERATOR RECORD NEVER BEFORE ACCOMPLISHED

The 40 HAZEN METALLIC RECUPERATORS now in operation have longer excellent service records than any other type of furnace recuperator. REPEAT ORDERS PROVE VALUE — 26 additional HAZEN RECUPERATORS are now under construction. All 66 of these HAZEN RECUPERATORS will INCREASE PRODUCTION AND REDUCE FUEL COSTS. Increased tonnage of up to 40 per cent and reduced fuel consumption of up to 35 per cent are being obtained on furnaces equipped with HAZEN METALLIC RECUPERATORS.



Shown above is an assembly of the heating elements and header boxes of the HAZEN METALLIC RECUPERATORS. The header boxes are located above the flue. The recuperator flue can be placed most advantageously, below or above ground level, or above furnace. The number of heating elements crosswise of the flue, as well as the number of boxes, will be dependent upon the capacity of the furnace. There are no joints exposed to hot gases, and no horizontal or fin tubes to accumulate flue dust.

OUTSTANDING ADVANTAGES OF HAZEN METALLIC RECUPERATORS

- Absolutely no leakage, hence all furnace controls remain as set.
- A cold air fan is used.
- The tubes are free to expand and contract.
- No connections inside flue.
- Low maintenance cost.
- Long life.
- Complete accessibility to all parts.
- Tube replacement with minimum delay on furnace.
- Instant air temperature response to change in flue gas temperature.

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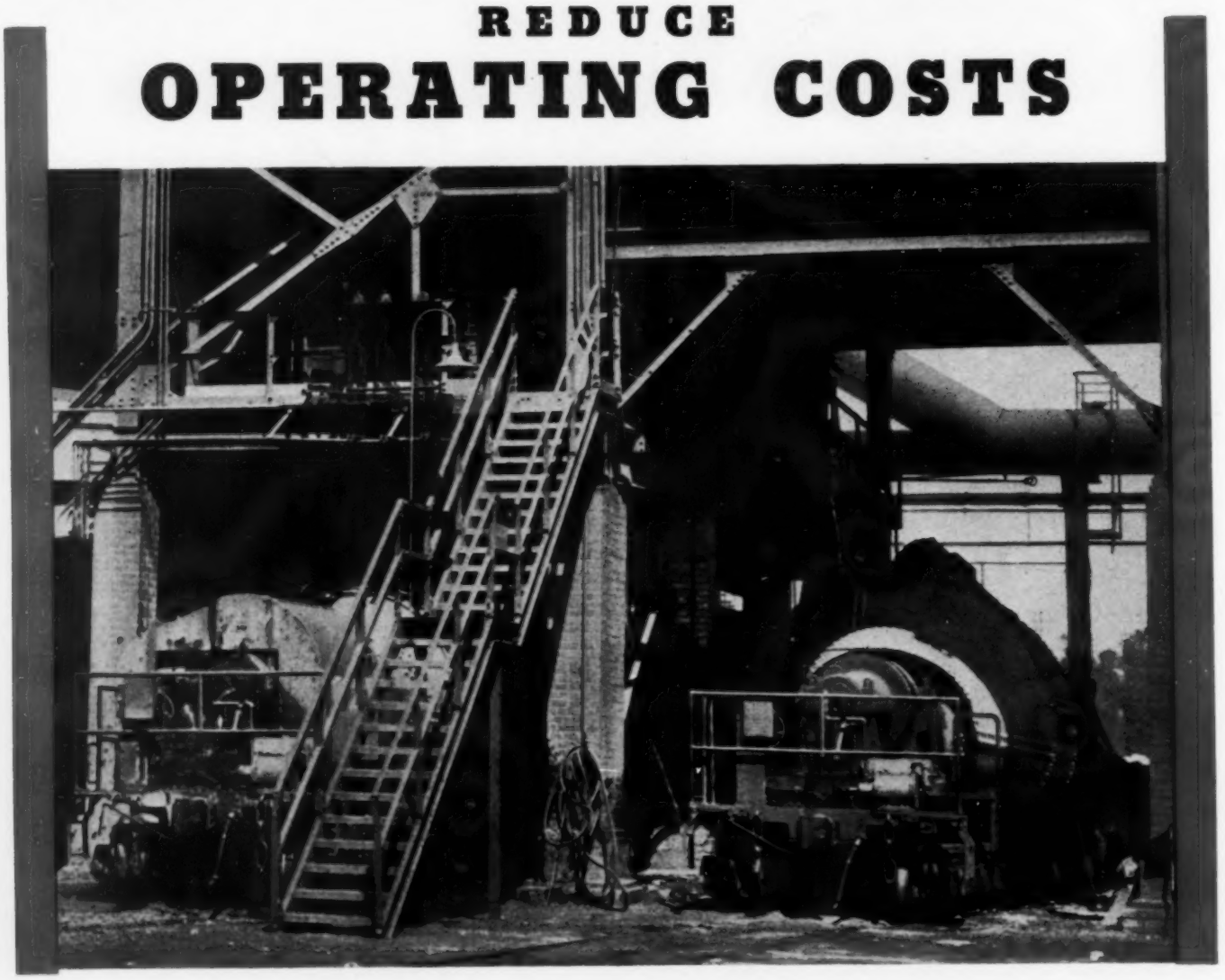

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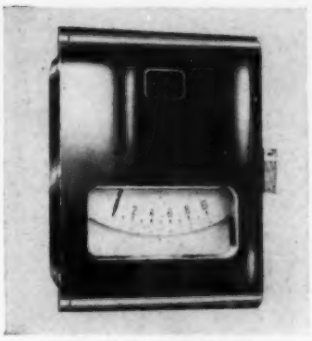
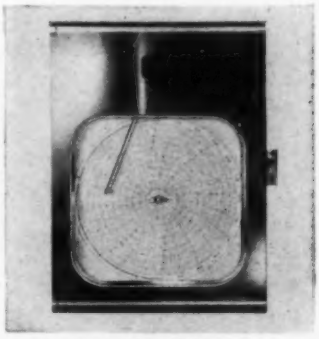
HOW TO SIMPLIFY PROBLEMS OF REMOTE MEASUREMENT AND CONTROL



THE TRANSMITTER



THE RECEIVER

Bristol Metameter* Telemetering Instruments Help Step Up Production... Save Time and Money... by Remote Measurement and Control of Pressure, Water Level, Flow, Temperature, Motion, Voltage, Current, Power and Totalized Load.

The Bristol Metameter Telemeter consists of three unit parts: Transmitter, Receiver, and interconnecting line which provides the electrical circuit between the two instruments.

The Transmitter is located close to the point of measurement. Its function is to transmit the readings to the receiver which can be any distance from a few feet to many miles away.

Readings can be transmitted over any two-wire circuit or its equivalent. Private wires, telephone circuits, radio (including microwave), or carrier current channels can be used.

THE TRIED AND PROVED TELEMETERING SYSTEM. Bristol Metameter Telemeter is the product of 37 years of pioneering research and development work. Bristol's continuous program of engineering research and development keeps the Metameter abreast of modern requirements, making it the most reliable and widely used instrument in the field of telemetering.

A few of the thousands of Bristol Metameter Telemeter users:

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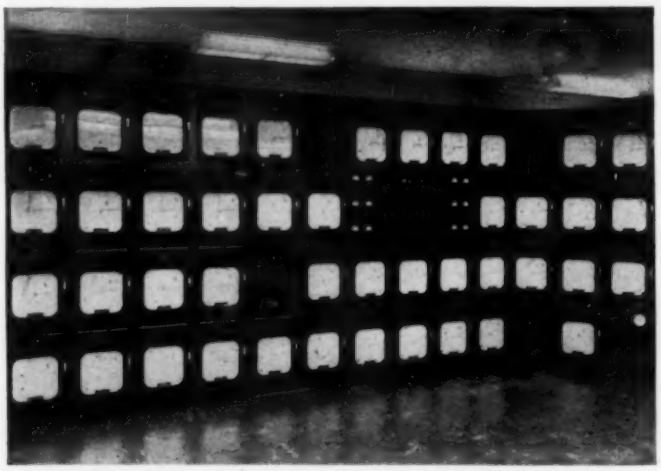
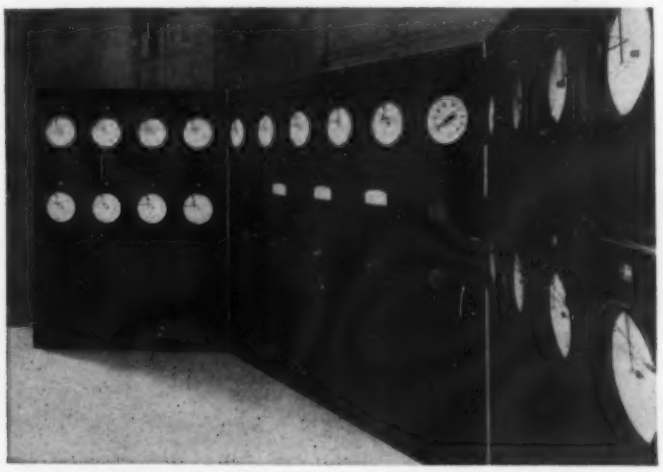


UNITED STATES STEEL CORPORATION These Recording Metameter Receivers provide fuel dispatcher with information concerning gas fuel supply and demand throughout plant at Gary, Ind., help maintain highest production of steel with lowest fuel cost.



AT THE FORD PLANT Metameter Receivers used by the Ford Motor Company in dispatching gas throughout its Dearborn plant, bring readings of pressure and flow to central point for use of dispatchers. This installation has been in operation since 1936.

THE DEPENDABLE GUIDEPOST OF INDUSTRY

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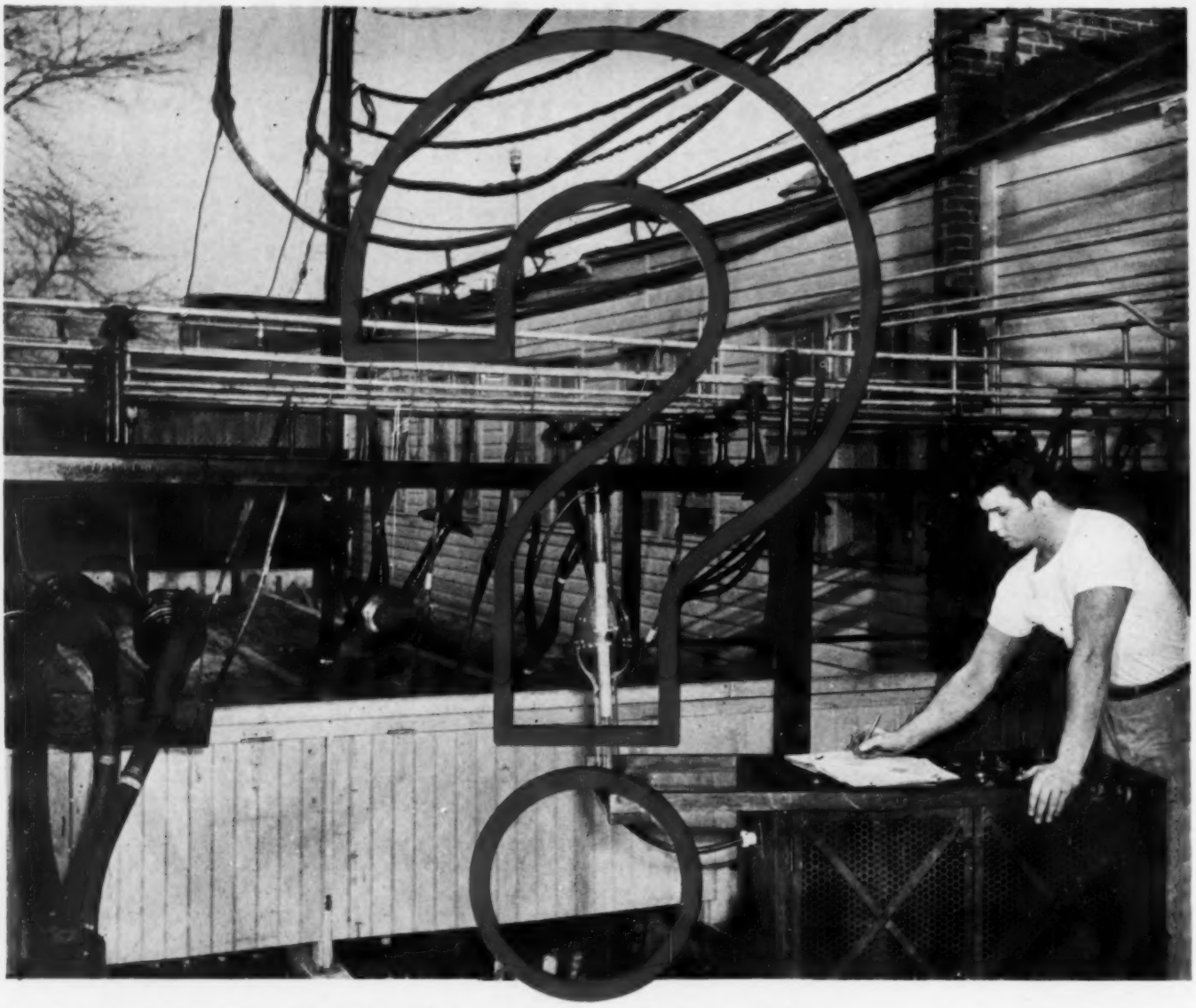


WHERE CABLE QUESTIONS OF THE FUTURE ARE BEING ANSWERED NOW

THIS is the Okonite proving ground. Within its bounds are concentrated the toughest cable tests that experience can devise. Here, lengths of every kind of cable—overhead or underground, clad in every type of insulation and protective covering—go in to stay for years, under continuous high voltage and alternating load cycles.

Underground cables are buried in "graves" filled with soils of all types, saturated with chemical wastes, sewage, salt brine... attacked by every enemy that may be encountered in actual installations. Overhead cables are exposed to a wide range of year-round weather conditions. Periodic examination of the cables includes disinterment, careful examination of coverings, complete electrical and physical measurements to determine rates of deterioration. Only the fittest can eventually survive.

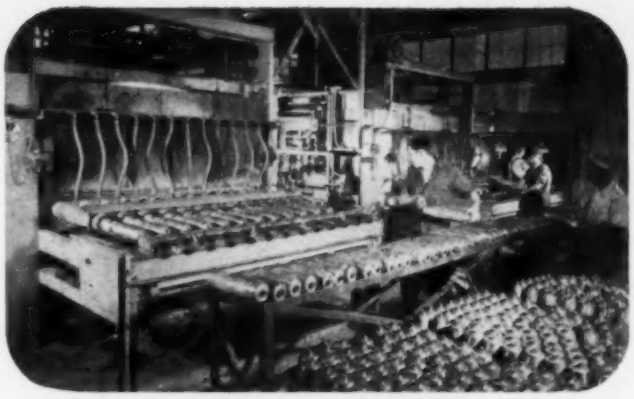
But this rigorous proving ground is open only to the "elect"—cable specimens that have previously survived months and years of hundreds of searching laboratory tests and experiments. Nor are all these results considered conclusive. No matter how successful in the laboratory and on the proving ground, every new Okonite wire or cable must pass the test of experience in the field before the final verdict is returned.

Now in its thirteenth year of operation, the Okonite proving ground is but one phase of the sternest testing techniques employed in the cable manufacturing industry today. It helps to explain why, tomorrow as in the past 72 years, you can continue to depend on Okonite for the right answers to your toughest cable problems. The Okonite Company, Passaic, N. J.

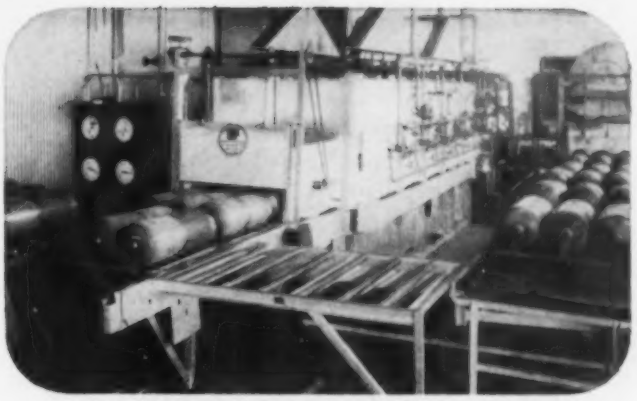
THE BEST CABLE IS YOUR BEST POLICY

OKONITE OKONITE SINCE 1878 *insulated wires and cables*

8341



Shell Forgings 75 mm, 90 mm, 105 mm and other sizes are scale-free hardened, uniformly, automatically and continuously, in these and other EF gas fired installations.



Gas Cylinders Compressed gas cylinders or tanks are continuously normalized and annealed—scale-free, inside and out—in this and other EF gas fired furnaces.

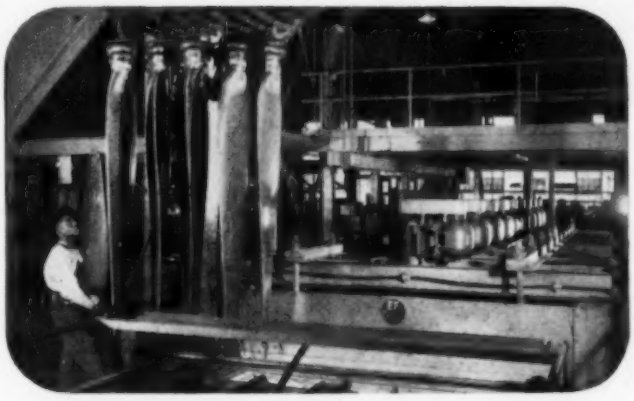
Typical EF Furnace Installations for Defense Production

We have the drawings and have already built these and many other defense production furnaces. Years of experience and complete manufacturing facilities enable us to give dependable service on furnaces for treating jet or propeller type engine parts; tank, automotive or aircraft parts; armor plate; metal powder products, ammunition components and other defense products.

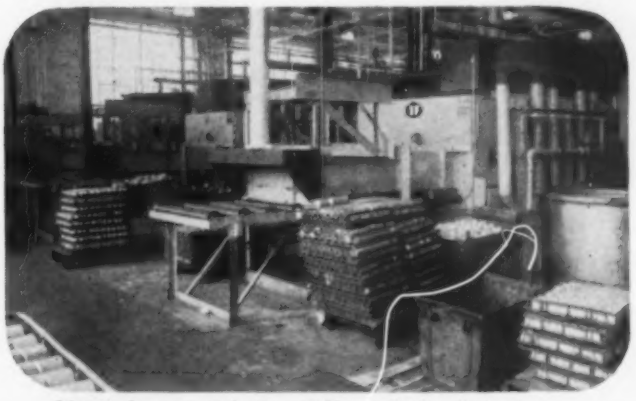
Ask for Bulletin 461-DP

THE ELECTRIC FURNACE CO. • SALEM, OHIO

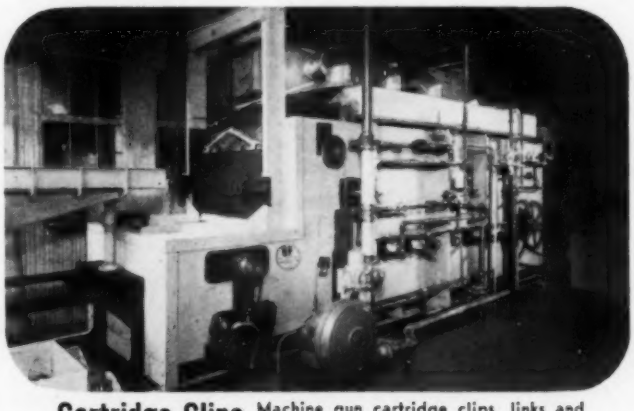
GAS, OIL OR ELECTRIC FURNACES, FOR ANY PRODUCT, PROCESS OR PRODUCTION



Aircraft Parts Propeller blades are uniformly heated and quenched in this EF continuous furnace. Types available for other propeller and jet type engine and aircraft parts.

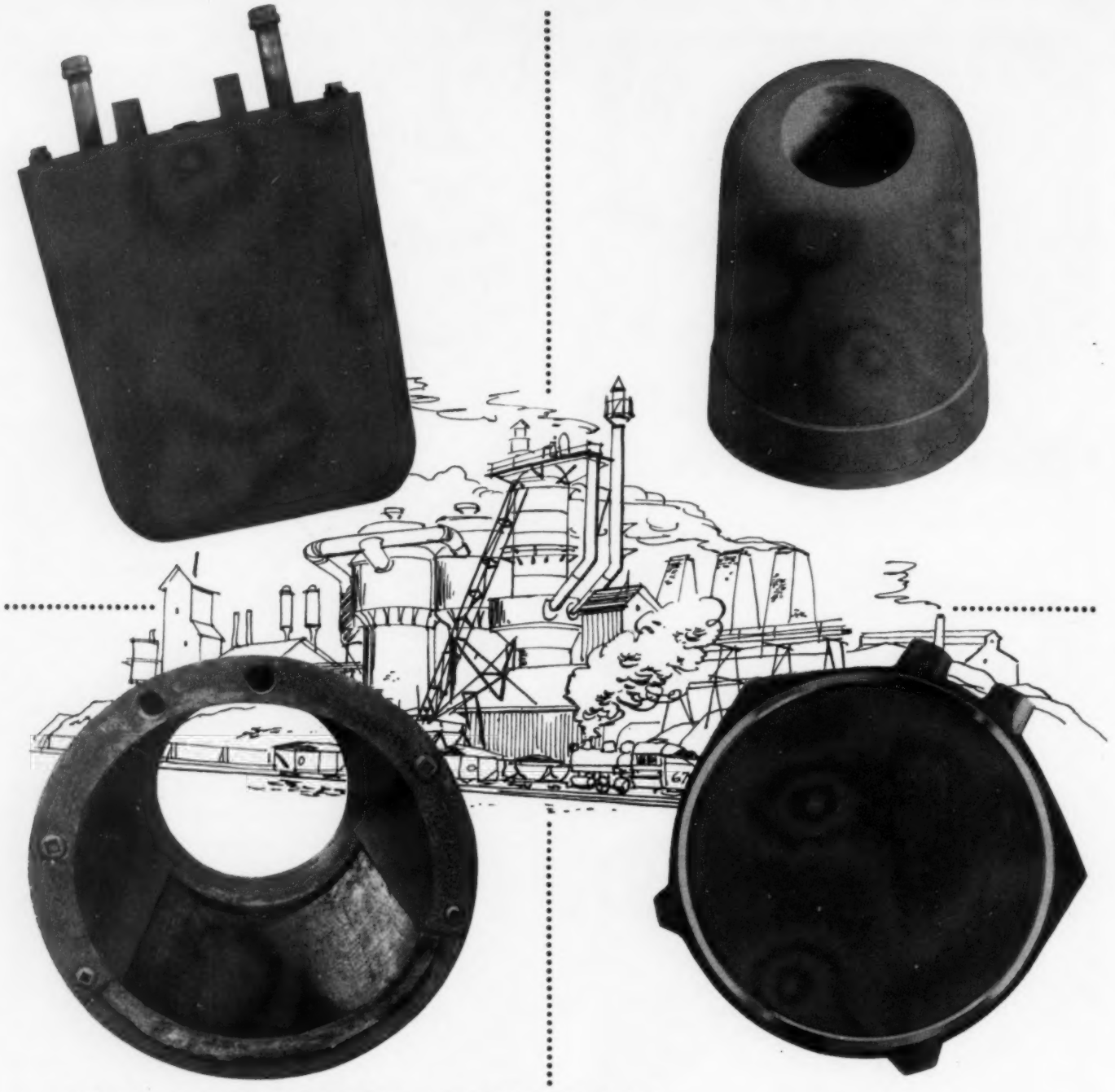


Shell Cases A battery of EF gas fired radiant tube continuous special atmosphere, clean annealing and stress relieving furnaces. Other types available for steel or brass.



Cartridge Clips Machine gun cartridge clips, links and other products are scale-free hardened —continuously in EF belt furnaces. Capacities, 175 to 2000 lbs. per hr.

Tank Armor Heavy castings, plate, weldments and other products are heat treated in these EF furnaces. Gantry cranes simplify loading, unloading and quenching.



N-B-M COPPER CASTINGS . . . the right answer

for greater production between stack shutdowns

N-B-M Copper Castings are the result of improved alloying and close foundry control perfected in our metallurgical and engineering research laboratories. These castings provide greater heat resistance for your most troublesome burn-out points, greater production between stack shutdowns. Always specify N-B-M Copper Castings—they give you longer, more economical service.

★

A COMPLETE LINE OF N-B-M CASTINGS

- Cinder Notch Coolers
- Bosh Plates
- Monkeys
- Stack Plates
- Tuyeres
- Tuyere Coolers
- Valves
- Valve Plugs
- Valve Seats
- Phosphorized Copper

AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION

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PLANTS IN: ST. LOUIS, MO. • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

FOR FURNACE ECONOMY AND EFFICIENCY—

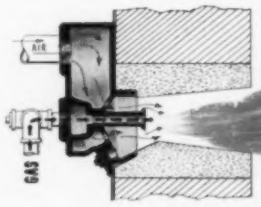
BLOOM *Engineered* COMBUSTION EQUIPMENT

The correct balancing of the many factors that affect furnace efficiency and economy is a matter of experience and skill. Bloom engineers understand the relationship between such factors as type and design of furnace, locations of burners, kind of fuel, speed of loading—and other considerations that enter into satisfactory furnace performance.

Some of the items of equipment designed and manufactured by Bloom Engineering are shown and described on these pages. The correct application of these products is an important part of our service.

FOR FLEXIBILITY AND EFFICIENCY

THE TEMPERED FLAME BURNER



With the Bloom TEMPERED FLAME BURNER, you get more from your furnace, more from your fuel! It provides greater flexibility because furnace temperatures as low as 400°F. or as high as 2450°F. can be obtained and maintained without difficulty. The Tempered Flame Burner will light at full capacity, and will burn as long as it has fuel.

Desired temperatures can be readily maintained uniformly throughout the furnace chamber. Faster heating is accomplished because cold spots are eliminated.

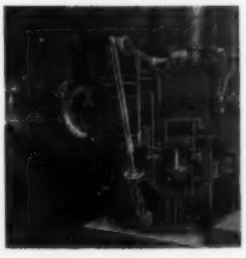
FOR FAST PRECISION HEATING

THE HTR BURNER

Recommended for use where quick heating and intense concentration of heat are desired, the Bloom High Thermal Release Burner will release up to 750,000 Btu per cubic foot of combustion volume. A turndown ratio of greater than 10 to 1 permits low input for holding purposes. With this burner, thin sheets can be heated without scale, and forgings can be heated with little or no scale, in a fraction of the time ordinarily required.

THE BLOOM-PAULSEN-STEINBART

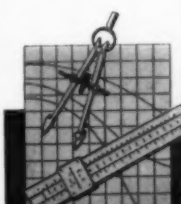
BLAST FURNACE STOVE BURNER



Provides proper combustion condition to develop correct temperature distribution for maximum stove heating capacity.

Patented arrangement of air distribution vanes make possible the construction of a compact burner unit.

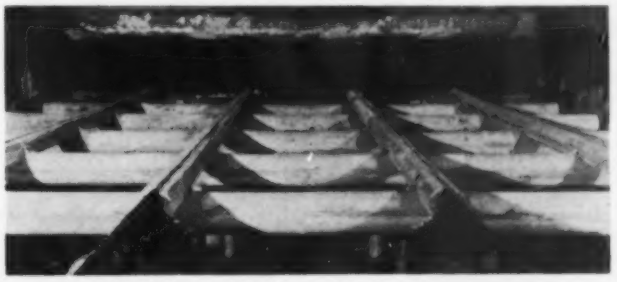
Correct measurement of air and gas flows is provided by an unusual burner construction.



BLOOM
ENGINEERING CO., INC.
857 W. North Avenue Pittsburgh 33, Pa.

FOR REDUCING HEAT LOSSES IN UNDERFIRED FURNACES

Ka-Weld REINFORCED PIPE INSULATION



Bloom Ka-Weld Precast, Reinforced Pipe Insulation, applied to water-cooled skid pipes, risers and crossovers, reduces the heat loss to the cooling water by as much as 82% at 2400°F. furnace temperature. Steel is heated more uniformly top and bottom, skid marks are practically eliminated, there is less slag. Consists of high grade refractory material, precast in convenient lengths and reinforced by a mesh of alloy steel. Easy to install and durable.

Top—Precast lower half section is held in place by welding exposed reinforcing alloy wire mesh. Middle—Top half similarly applied. Bottom—Completed covering.

FOR ACCURATE REGULATION OF LIQUID FUEL FLOW

CONSTANT-FLOW VALVE

Assures uniform liquid flow, regardless of fluctuations of pressure. With the ordinary control valve, variations in pressure cause variations in flow. But with the Bloom Constant Flow Valve, a uniform flow of fuel is assured at all settings.

Other BLOOM Products Include . . .

- Long Flame Gas and Oil Burners
- Hot Air Burners
- Nozzle Mix Burners
- Raw Producer Gas Burners
- Steam-Oil Pressure Ratio Regulator
- Low Btu Gas Burners

DOWELL SERVICE

CHEMISTRY APPLIED TO MAINTENANCE CLEANING PROBLEMS

This Company asked:

Can you clean waste heat boilers?

Dowell Service cleaned *TWO* in 24 hours!

A hard, porous silicate deposit, ⅛ to ¼ of an inch thick, had formed on the tubes of two 100 HP waste heat boilers in a large steel plant. Much of this deposit had sloughed off and become cemented together until in many places the annular space between the tubes was completely filled. Steam production was too low.

Dowell Service cleaned both boilers in 24 hours. An inspection of the tubes showed that all deposits had been satisfactorily removed. Steam production was greatly increased. The operator was pleased with the job and has used Dowell Service twice since for maintenance cleaning of the same equipment.

Maintenance engineers in industrial plants throughout the country have found that Dowell Service can provide *fast, effective and economical* cleaning of boilers, condensers, heat exchangers, water lines and other equipment. Special liquid solvents, designed to dissolve and disintegrate costly, profit-stealing deposits, are pumped into the equipment, reaching surfaces inaccessible to other cleaning methods. The entire job is finished in a matter of hours, without dismantling.

There is a place in your maintenance program for Dowell Service. Experienced engineers will be glad to consult with you on your particular problem. Call Dowell now.

Other recent Dowell jobs:

Gas Washer cleaned in 4 hours without cutting water to sprays during cleaning. Result: Pressure drop across washer reduced from 20.25" to 6.75".

•

Dust catcher cleaned in 13 hours without dismantling. Result: Prior to Dowell Service, catcher dumped 5 tons; after, 30 to 35 tons per day.

•

Production from two water wells in a small manufacturing plant had declined because of deposits clogging the producing formation and screens. Dowell Service increased the water flow 300%.

CALL

DOWELL INCORPORATED • TULSA 3, OKLAHOMA

New York 20	Buffalo 2	Kansas City 8	Mt. Pleasant, Mich.
Boston 16	Cleveland 13	Wichita 2	Hamilton, Ohio
Philadelphia 2	Pittsburgh 19	Oklahoma City 2	Charleston 27, W. Va.
Baltimore 18	Detroit 2	Houston 2	Salem, Illinois
Wilmington 99	Chicago 2	New Orleans 12	Borger, Texas
Richmond 19	St. Louis 8	Ft. Worth 2	Midland, Texas
Jacksonville	Indianapolis	Shreveport 69	Wichita Falls, Texas
Atlanta	Louisville	Anniston, Alabama	Lafayette, La.

Long Beach, Oakland, Casper: Dowell Associate—International Cementers, Inc.

★ *Maintenance cleaning service for industrial heat exchange equipment.*
★ *Chemical services for oil, gas and water wells.*
★ *Magnesium anodes for corrosion control.*
★ *Saran rubber corrosion resistant tank linings.*

DOWELL

A Service Subsidiary of

THE DOW CHEMICAL COMPANY

DOW

Date-line Diary...

March 1

▲ The Department of Commerce reports that the backlog of government buying on January 31 had increased to $41,700,000,000, a jump of $3,700,000,000 during the month.

March 2

▲ Government issued an order cutting back natural rubber for civilian products and limited or banned the use of natural rubber in 40,000 civilian items.

March 5

▲ Based on AISI reports from companies having 93 per cent of the steel capacity of the industry, the operating rate for the week beginning March 4, 1951 is scheduled at 101.0 per cent of capacity. This is equivalent to 2,019,000 tons compared with 1,995,000 tons one week ago.

▲ The Jones & Laughlin Steel Corp. filed with the SEC a registration statement covering 1,000,000 additional shares of common stock.

▲ George M. Humphrey, president of M. A. Hanna Co., told Congress that the program for developing iron ore deposits in Labrador has been radically stepped up.

March 6

▲ Vanadium Corp. of America, as a result of purchases of properties in South Africa, will more than double its production of metallurgical chrome ore.

▲ General Motors Corp. set new earning records for 1950 with $834,044,039 or $9.35 a share after preferred dividends on net sales of $7,531,086,846. Number of vehicles produced rose to 3,653,358.

▲ The NPA announced that, effective March 16, production of electric power equipment costing over $15,000, will come under their control.

March 7

▲ The Government suspended purchasing of tin for the national stockpile and prices dropped 8½¢ in New York to $1.71½ a lb.

▲ A. B. Homer, president Bethlehem Steel Co., stated that its current expansion program will give the company 56 per cent more capacity than it had at the start of World War II.

▲ Defense Mobilizer C. E. Wilson wrote a Virginia congressman that present expansion program of the steel industry should meet requirements, and that it may be uneconomic to consider further expansion at this time.

March 8

▲ The government put into effect a cut-back of 20 per cent from 1950 levels of the amount of steel that can go into new autos and other consumer durable goods during the second quarter of this year. Cutbacks of 35 per cent for aluminum and 25 per cent for copper were also established.

March 9

▲ Treasury Department announced that the interest rate on new bonds will be 2¾ per cent, up from the 2½ per cent now in effect. The new bonds will not be marketable but may be exchangeable for five year 1½ per cent notes.

▲ World tin prices dropped to $1.39 a lb in New York.

▲ Commerce Department reported that personal income in January declined to an annual rate of $239,000,000,000.

▲ The ARCI announced that orders for new freight cars in February totaled 15,947; deliveries were 5,842 leaving a backlog on March 1 of 154,861, an all-time high.

March 10

▲ Commerce Department reported that business inventories went up $11,300,000,000 in January to a total of $63,100,000,000.

March 11

▲ Jones & Laughlin Steel Corp. closed its Pittsburgh Works as a result of a plant railroad slowdown.

March 12

▲ General Refractories Co. announced that they will spend $12,000,000 on an expansion program which will be completed during 1951.

▲ Based on AISI reports from companies having 93 per cent of the steel capacity of the industry, the operating rate is scheduled at 100.1 per cent of capacity for the week beginning March 12, 1951. This is equivalent to 2,001,000 tons of steel compared with 2,019,000 one week ago.

▲ The AISI reports that steel production in February totaled 7,762,000 tons, higher than ever before for the month, and almost 1,000,000 tons higher than 1950. Furnaces operated at 97.1 per cent of capacity and the rate was affected by the railroad switchmen strike.

March 13

▲ International Nickel Co. of Canada, Ltd. in their annual statement reported that nickel deliveries in 1950 totaled 256,410,543 lb compared with 209,292,257 lb in 1949.

▲ NPA announced that effective immediately the RFC becomes the sole importer of tin. On May 1, the NPA will start complete allocation of pig tin to domestic users.

▲ NPA increased the amount of priority orders which must be filled by the steel mills on thirty products.

March 14

▲ The Woodward Iron Co. awarded Koppers Co. a contract for constructing a 30-oven battery at its Woodward, Ala. plant.

▲ Granite City Steel Co. stockholders approved a 2 for 1 split of the common stock.

▲ AISI reports that January 1951 set a new record for steel shipments with 6,904,688 tons.

March 15

▲ United Engineering and Foundry Co. reported all time record sales for 1950 of $66,860,759 or 5.7 per cent over the previous year. Net income totaled $5,298,884. Backlog beginning in 1951 totaled $62,600,000.

▲ The F. W. Dodge Corp. reports February construction contract awards in the 37 states east of the Rockies totaled $1,140,527,000, 9 per cent higher than January.

▲ The ICC authorized freight rate increases ranging from 2 to 4 per cent.

▲ The government reported that certificates of necessity for 5 year write-offs totaled $2,683,000,000.

March 16

▲ Pittsburgh Coke and Chemical Co. reports that it will build a new blast furnace at its Neville Island plant.

▲ U. S. Steel Co. awarded Arthur G. McKee Co. a contract for two 28-ft blast furnaces at its new Fairless Works.

March 17

▲ The Office of Defense Mobilization reported that the armed forces placed orders for $5,700,000,000 in January and $4,700,000,000 in February.

▲ Ward's Automotive reports estimate that motor vehicle production in the first six months of 1951 may reach a record of 3,900,000 units.

▲ Bethlehem Steel dropped its option to build and operate the proposed New England Steel Co. as a result of an unfavorable report on the mill's economic possibilities. A new report is now being prepared.

March 18

▲ France is building $25,000,000 worth of steel mill equipment for a mill at Paz De Rio in Colombia, and $12,000,000 worth for a plant to be built at Chimbote, Peru.

March 19

▲ The government awarded Timken Roller Bearing Co. a certificate of necessity which will cover three top-charge electric furnaces.

▲ Based on AISI reports from companies having 93 per cent of the capacity of the industry, the operating rate beginning March 19 is scheduled at 101.1 per cent of capacity. This is equivalent to 2,021,000 tons compared with 2,001,000 tons one week ago.

▲ AISI reports the payroll of the iron and steel industry totaled $245,294,000 in January, a new record. Hourly payments averaged $1.93 and 657,200 workers averaged 41.6 hours per week.

▲ Connors Steel Co. awarded contracts for its plant expansion which include an additional electric furnace, billet heating furnace and 18-in. break-down mill.

March 20

▲ Production of aluminum in January totaled 135,907,016 lb, and shipments of aluminum sheet and plate went up to 112,070,040 lb.

▲ Bethlehem Steel Co. announced that it will start development work on the newly discovered iron ore deposits south of Reading, Pa.

March 21

▲ NPA planned to cut back tin available for beer cans and similar uses about 25 per cent in the second quarter.

March 22

▲ Venezuelan ore reached Baltimore for the first time thus starting what may be a new era in ore supply.

March 23

▲ National Machine Tool Builders Association reported that machine tool orders in February were the largest in nine years.

March 24

▲ Railroad's changed their petition for a 6 per cent boost in freight rates, which they requested on January 16, to a 15 per cent boost.

▲ Government started an inquiry into reported violations on price ceilings on iron and steel scrap.

▲ Labor Department reported that factory employment went up to 45,300,000 or the highest since V-J day.

March 25

▲ The AISC reported that February bookings of fabricated structural steel totaled 200,788 tons. Shipments totaled 154,783 tons, leaving a backlog of 2,228,495 tons.

March 26

▲ The AISI reports steel production for the week beginning March 26 will set a new record of 2,069,000 tons, compared with 2,021,000 tons one week ago. Operating rate will be 103.5 per cent of capacity.

March 27

▲ National Steel Corp. set new production, shipment, sales and earning records in 1950. Net earnings were $57,814,974 or $7.85 per share. Total sales were $537,024,673.

▲ The Commerce Department reports spending for new plant and equipment in 1951 should reach a new high of $23,910,000,000, 29 per cent above 1950.

▲ In January, U. S. imports set a new record of $1,016,000,000, and exports dropped to $957,000,000.

▲ Truscon Steel Co., a subsidiary of Republic Steel Corp., received an $18,000,000 contract to make tread blocks for tanks.

▲ The OPS issued food price controls of the mark-up type.

▲ Defense Mobilizer Wilson reported that the U. S. by 1953 will be able to produce sufficient weapons to fight a major war.

▲ National Fire Protection Association reports that large loss fires in 1950 increased 12 per cent over the previous year.

March 28

▲ The General Service Administration announced that government has placed machine tool orders totaling $63,177,019 with thirteen manufacturers.

March 29

▲ The Koppers Co. is planning to build a plant at Fontana, Calif. to produce enamel pipe coatings and roofing materials.

▲ Weirton Steel Co. is planning a 1200-ton blast furnace at Weirton which will make a total of four at this plant.

▲ The Senate Rules Committee of the Ohio State Legislature voted to suspend further consideration on the proposed conveyor for carrying iron ore and coal between E. Liverpool and Cleveland, Ohio.

▲ Sharon Tube Co. announced plans for building a $2,000,000 continuous butt-weld tube mill. Contract for mill has been awarded to Aetna-Standard. The company plans to increase its capital stock from $200,000 to $2,000,000 to finance the expansion.

▲ The Five Nation Conference on tin broke up in failure.

March 30

▲ Wilson predicted that defense production will reach $50,000,000,000 in the fiscal year beginning July 1, 1951. Wilson stated that inflation could wreck the program.

▲ Air Reduction Co. is starting work on a $10,000,000 plant at Calvert City, Ky. which will furnish calcium carbide.

March 31

▲ Commerce Department reports that new construction put in place in the first quarter of 1951 totaled $6,163,000,000 for the largest first quarter on record.

▲ Alan Wood Steel Co. reported net income for 1950 of $2,546,902 or $3.92 a share after payment of preferred dividends.

▲ The AISI reported that steel companies spent the equivalent of $24.50 for every person in the United States during the years 1946 to 1951 in order to expand and improve iron and steel making facilities. In 1951 they will spend $1,200,000,000.

▲ AISI reported that 9,200,000 tons of iron ore were imported into the United States from foreign countries for a new record.

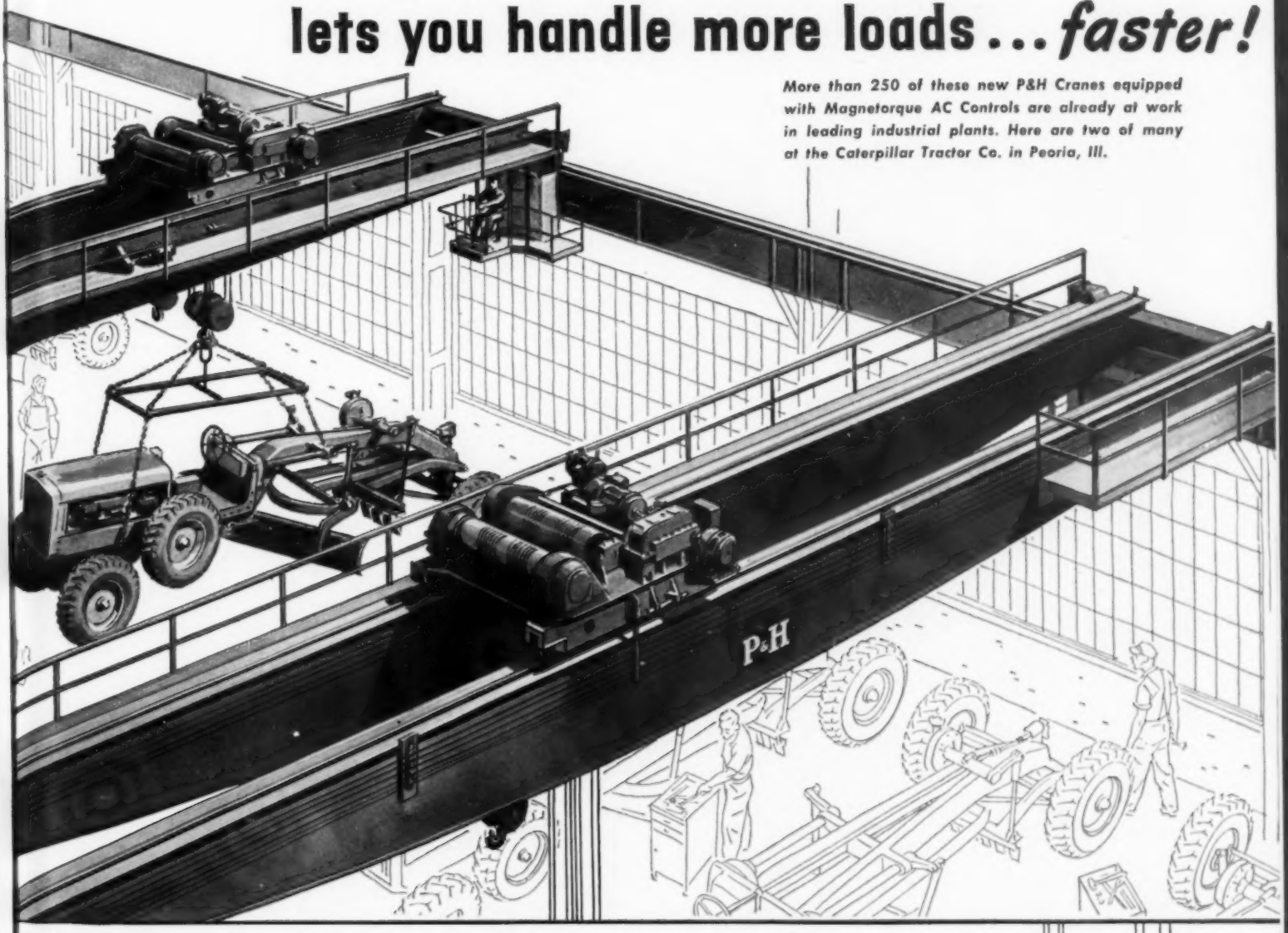
▲ The AISI reported that as a result of the alloy savings program, the production of nickel chromium steel fell 37 per cent and nickel molybdenum steel fell 47 per cent in the last six months of 1950. On the other hand output of triple alloy steels rose 69 per cent.

P&H OVERHEAD CRANES

MAGNETORQUE*

lets you handle more loads ... *faster!*

More than 250 of these new P&H Cranes equipped with Magnetorque AC Controls are already at work in leading industrial plants. Here are two of many at the Caterpillar Tractor Co. in Peoria, Ill.



You'll be amazed how simple — how completely responsive this control can be — under *all load conditions!* Speed when you want it — precision when you need it. Unexcelled performance! This kind of crane service means faster, easier handling of *every* load — *more work per shift* in busy plants.

And far fewer service interruptions, too. Magnetorque eliminates the old mechanical load brakes. There's no frictional wear — no bothersome adjustments to waste your time — no control contacts to maintain. And Magnetorque will last the life of your crane.

*T. M. of Harnischfeger Corporation for electro-magnetic type brake.

OVER 17,000 P&H CRANES SERVE AMERICAN INDUSTRY... FAR MORE THAN ANY OTHER

P&H

"job engineered" to fit your needs

P&H OVERHEAD CRANES

4455 W. National Avenue
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HARNISCHFEGER CORPORATION

P&H

ELECTRIC WELDERS AND ELECTRODES

Is UPKEEP COST your magnet problem?

Although it looks and lifts like new, this Ohio Magnet is actually 22 years old. Until recently, upkeep cost was zero. Then a ground developed in the terminal box and the magnet was shipped to our plant, where repairs were quickly completed without disassembly.

Upkeep cost? Under $100—*less than $5 a year for 22 years!*

Next time you buy a lifting magnet, remember that heavier construction assures extra years of low-cost life. Send your order to Ohio—*27 years a leader in magnetic materials handling.*

This magnet averaged less than $5 a year!

OHIO PROTECTO-WELD MAGNET is welded *on top*, where weld cannot be dented in. Sizes include 39, 46, 55 and 65-inch diameters. Ohio also builds magnet control equipment.

In addition to lifting magnets and control equipment, Ohio Electric also makes fractional horsepower motors, heavy duty electric cable hoists, nail-making machines and drill presses.

THE OHIO ELECTRIC MFG. CO. • 5900 MAURICE AVENUE • CLEVELAND, OHIO

CHESTER BLAND, *President*

Ohio ELECTRIC

A-2012

Industry News...

U. S. ECONOMIC GEOLOGIST CLAIMS RUSSIA HAS MINERAL RESOURCES FOR INDUSTRIES

▲ Within her own boundaries or within easy access of her borders, Russia has all the mineral resources required for an industrial economy, a top-ranking geologist declared recently.

Speaking at Northwestern University's Centennial Year Conference on Science, Technology and World Resources, Thomas S. Lovering, economic geologist for the U. S. Geological Survey, gave the following "inventory" of the Sovet Union's resources :

Coal — plentiful. Coal production has been doubling every five years. If this growth continues, Russia's production will equal that of the United States by 1960.

Iron and steel—during past several years, iron and steel industry has been expanding at rate of two to three million tons a year. Russia is now producing over 20 million tons of pig iron yearly and is second only to the United States, whose current production is over 50 million tons annually.

Copper—present supplies are adequate for her present economy but will have to be supplemented by new discoveries or substantial imports during the next decade if her industrial expansion continues.

Aluminum ore—not well supplied. Although her output of aluminum has expanded greatly, Russia has been forced to use relatively poor ores.

Lovering said Russia is well supplied with nickel, platinum, chromium and manganese.

The Soviet has little tungsten and tin, according to the geologist, but both metals are available from China in quantity. Russia's petroleum supplies are adequate for her needs, Lovering stated, and her reserves are substantial.

"Details of the uranium deposits of Russia," according to Lovering, "are virtually unknown to engineers outside the Soviet Union. No extensive Russian deposits have ever been described, and it is probable that a large part of the pitchblende now used has come from Joachimstahl in Czechoslovakia, the district that supplied the Curies with the ore from which radium was first isolated."

The geologist said Russia has substantial sedimentary deposits ranging in grade from a few thousandths to as much as one-tenth of one per cent in uranium.

"The theoretical energy content of fissionable uranium," Lovering explained, "is approximately three million times that of coal. Thus, on an economic basis alone, work would be justified on such deposits if a substantial part of this energy could be made available."

There is no evidence of any high grade uranium ore in Russia, the speaker declared, but there are reserves of seven or eight hundred tons of uranium oxide in medium grade ore—material averaging a few tenths of one per cent.

He pointed out that Russia, like other petroleum rich countries, has large reserves of low grade black shale containing a few hundredths of one per cent of uranium oxide "that could yield ultimately as much as 45,000 tons of uranium oxide."

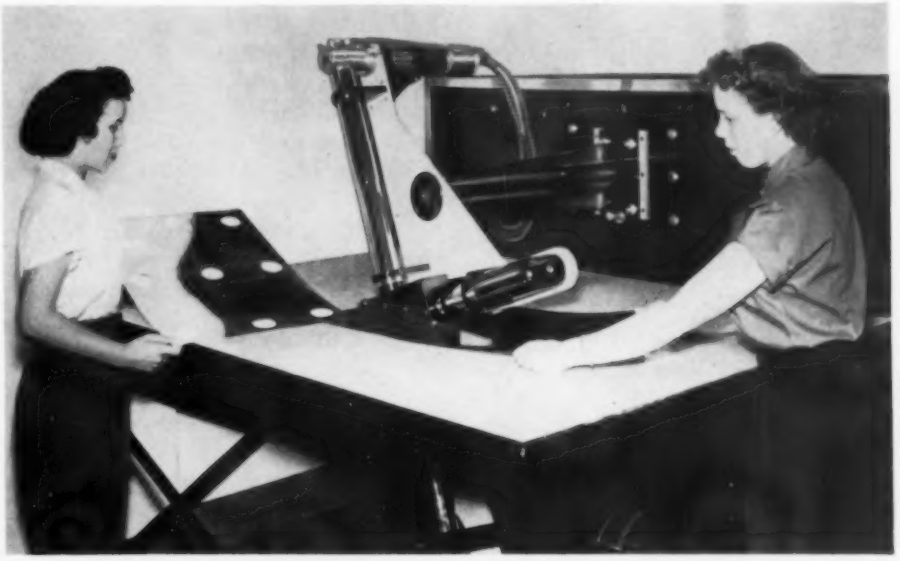
GOVERNMENT WILL AID LIQUID FUEL VENTURES

▲ Secretary of the Interior Oscar L. Chapman announced that he is calling upon private enterprise, with government assistance under existing legislation, to establish promptly a synthetic liquid fuels industry based upon coal and oil shale. He made this disclosure in transmitting to the Congress a report on Bureau of Mines synthetic liquid fuels research during 1950.

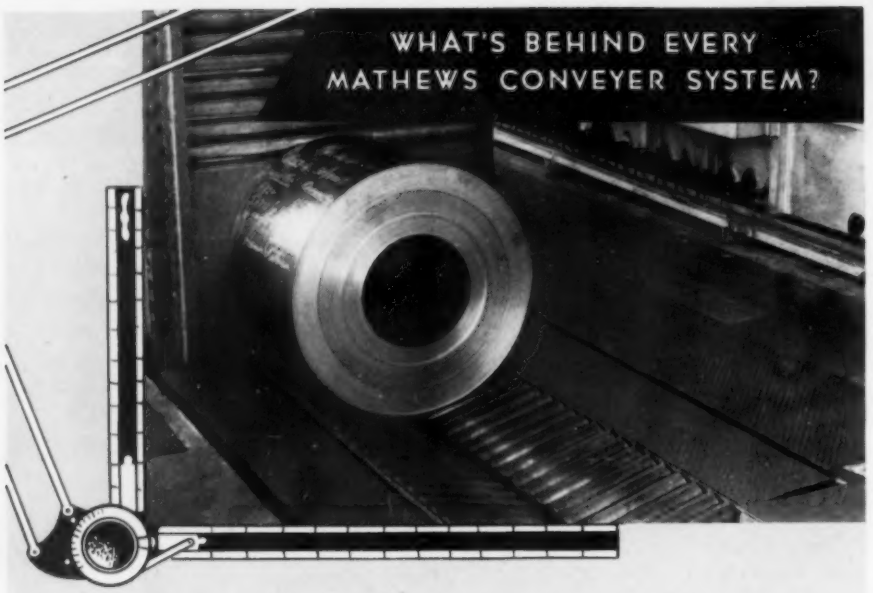
The secretary pledged the "full support" of the Department of the Interior to "competent organizations or groups of organizations" offering sound proposals for undertaking commercial oil-shale operations.

He added that the department will

TESTING DEVICE SAVES TIN



U. S. Steel scientists have combined Geiger counters and x-rays to produce an automatic testing device that will save many tons of scarce tin annually. One of the new testing machines went into operation at the Gary, Ind., sheet and tin mill of U. S. Steel Co. Others are being used in the company's Irvin works in Pittsburgh and at two other U. S. Steel subsidiaries, the Pittsburg, Calif., plant of Columbia Steel Co. and the Birmingham plant of Tennessee Coal, Iron and Railroad Co. Enough tin plate will be saved annually with the new testing method at the Gary plant to manufacture 1,000,000 tin cans.



A BALANCED ENGINEERING STAFF

● No one can be all things to all people, and a conveyer engineer is no exception to this rule. In the large corps of Mathews Engineers, in the field offices and at the three plants, are many specialists in one or more of the various types of equipment we manufacture, and in the industries which we serve. Some are especially skilled in the design and application of Belt Conveyers. Others are specialists in the design of heavy conveying machinery. There are experts in foundry conveying problems, and those with special understanding of the design and application of Steel Mill conveyers. And so on. There are creative men, experienced detailers, and engineers specializing in the application of electrical and hydraulic equipment. It is indeed a balanced engineering staff. And, that's why we can say, "Whether a load weighs 1 pound or 50,000 pounds, it is a job for Mathews Engineers."

Engineering offices or sales agencies are located in principal American and Canadian cities.

MATHEWS CONVEYERS

GENERAL OFFICES . . . . . *Mathews Conveyer Company*
ELLWOOD CITY, PENNSYLVANIA

PACIFIC COAST DIVISION . . *Mathews Conveyer Company West Coast*
SAN CARLOS, CALIFORNIA

CANADIAN DIVISION . . . . . *Mathews Conveyer Company, Ltd.*
PORT HOPE, ONTARIO

Engineering Offices or Sales Agencies in Principal American and Canadian Cities

also encourage the construction of one or two plants to produce synthetic liquid fuels by direct hydrogenation of coal. Regarding the other coal-to-oil process being studied by the Bureau of Mines—gas synthesis—he observed that further pilot plant and demonstration plant testing is necessary.

AISC WILL AWARD TEN $1000 SCHOLARSHIPS

▲ To encourage future engineers to enter the fabricated structural steel industry, the American Institute of Steel Construction will award 10 scholarships of $1,000 each in American colleges and technical schools during 1951.

Last year, in a national competition, 10 high school graduates received the first scholarships offered under the Institute's new educational program.

The objective of the Institute's scholarship plan, according to L. Abbett Post, executive vice president, is to train engineers and administrators for the industry, although recipients of the scholarships are under no obligation to continue in the industry after graduation.

To be eligible for a scholarship a candidate must be proposed by the executive head of a member company of the Institute. A candidate need not be an employee, or the dependent of an employee, of the sponsoring company.

Scholarships are available only to students who pursue the full course in civil engineering offered at any one of 125 colleges located throughout the country.

VANADIUM CORP. DOUBLES CHROME ORE PRODUCTION

▲ Vanadium Corp. of America will more than double its production of metallurgical chrome ore as a result of the recent purchase by its subsidiary, Rhodesian Vanadium Corp., of properties in Southern Rhodesia, South Africa, the area in which the company has operated since 1926, it was announced recently.

The acquisition, which multiplies the company's chrome ore reserves, will provide practically all of its

(*Please turn to page 154*)

F·E·I·

FOR ENGINEERING IMPROVEMENTS *in*

Open Hearth FURNACES

F. E. I. BUILDS

OPEN HEARTH FURNACES,

SOAKING PITS—*regenerative and one-way recuperative,*

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GALVANIZING FURNACES *for tubes, sheets, metalware and jobbing,*

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Furnace Engineers, Inc. provides the latest advancements in Open Hearth Furnaces that insure top performance. Our staff includes men with up to 30 years or more experience . . . specialists in the design, construction and operation of all types of industrial furnaces.

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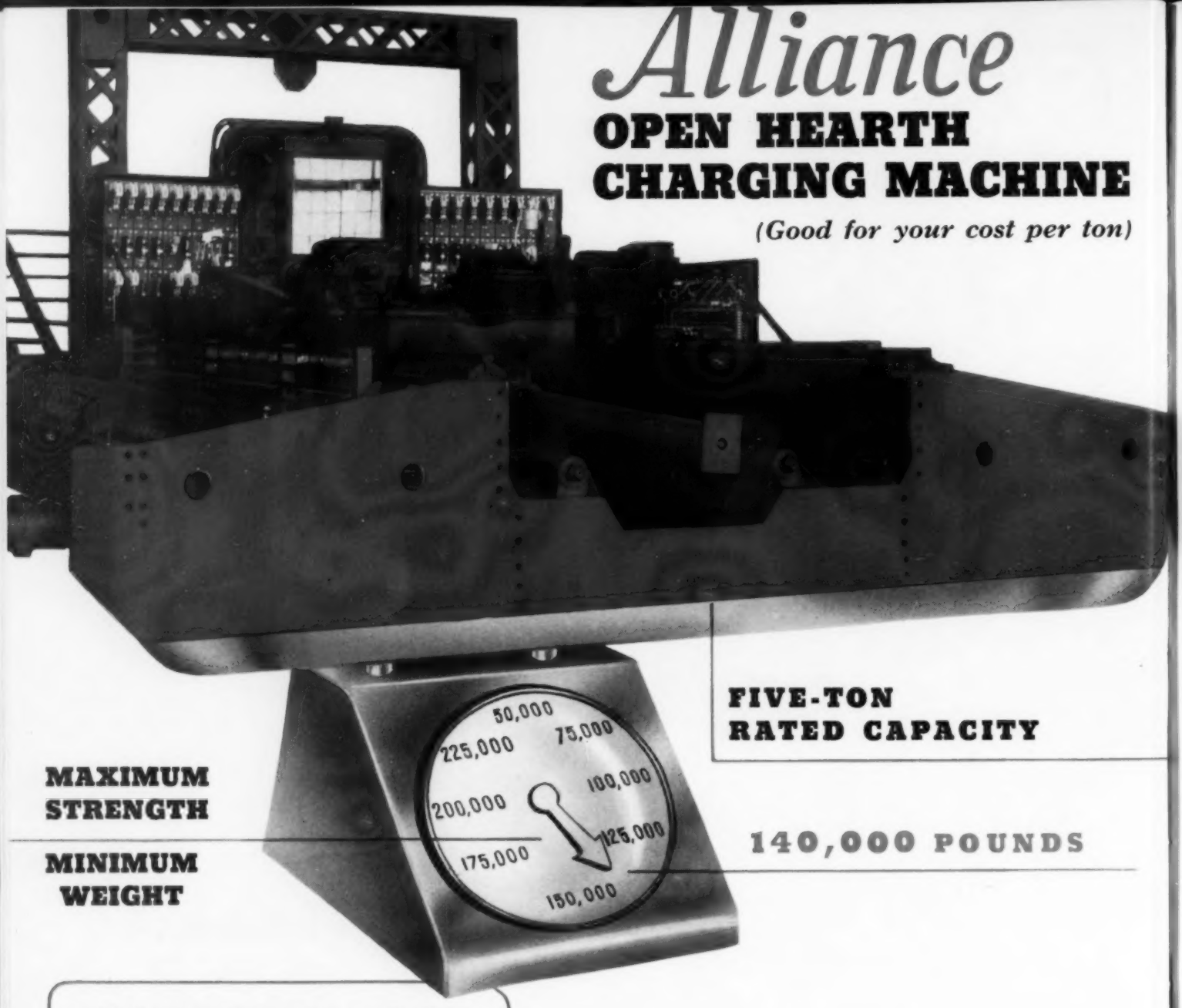
7

Alliance
OPEN HEARTH CHARGING MACHINE

(Good for your cost per ton)



FIVE-TON RATED CAPACITY

MAXIMUM STRENGTH

140,000 POUNDS

MINIMUM WEIGHT

with these exclusive *Alliance* features

- ★ Spring-loaded pitman prevents shock on peel.
- ★ Spring-mounted trolley wheels minimize shock to the operator.
- ★ Hydraulic lock rod gives operator finger-tip control.
- ★ All gears fully enclosed and run in oil.
- ★ Girders are made of two wide-flange beams welded together to form a box section and reinforced by diaphragms.
- ★ Machinery deck riveted to bottom flange of main and auxiliary girder keeps machine in perfect alignment.

● This new 5-ton capacity open hearth Charging Machine has all the special features found in larger Alliance Machines.

This all-welded Charging Machine replaced obsolete charger and required no building reinforcements due to its lighter weight. **Strength was not sacrificed.**

Alliance, world's largest builder of the world's largest cranes, has developed many special machines for moving unusual loads for heavy industries.

Alliance Engineers will be happy to discuss your specific requirements or give you general information of interest to your specific industry. Contact Alliance today.

THE ALLIANCE MACHINE COMPANY

MAIN OFFICE
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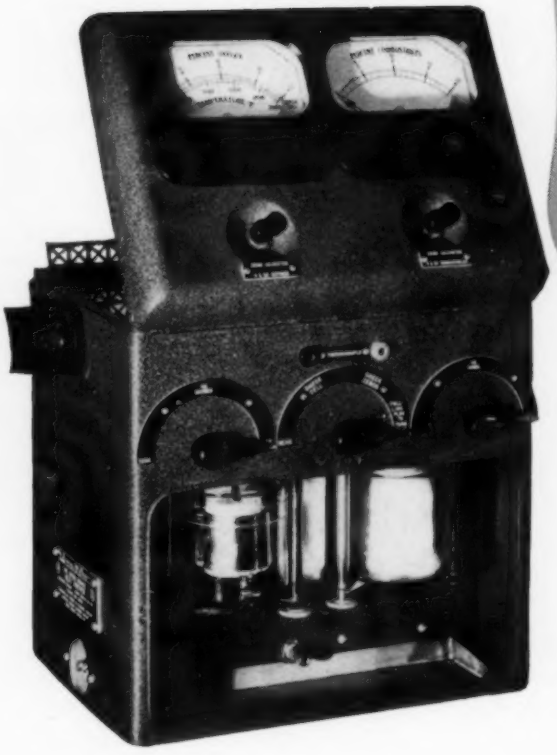
LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION

I SPY



Combustion Facts Fully Revealed by Fast, Simple Heat Prover Test

This scientific combustion analyzer—the Cities Service Heat Prover—gives you the real "inside" on furnace combustion conditions. Its plain, quick, accurate work lets you know:

How much excess oxygen is present

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Without endless trial-and-error you can proceed to conserve fuel and increase furnace output. This is substantiated by records made on all types of furnaces. See for yourself how productivity can be improved. Call or write *today* for a Cities Service Heat Prover demonstration . . . readily arranged in your plant. Or for further details return the coupon below.

Not an instrument you buy,
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Write or call us today.

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Without obligation please send your booklet, "Combustion Control for Industry" and Heat Prover information.

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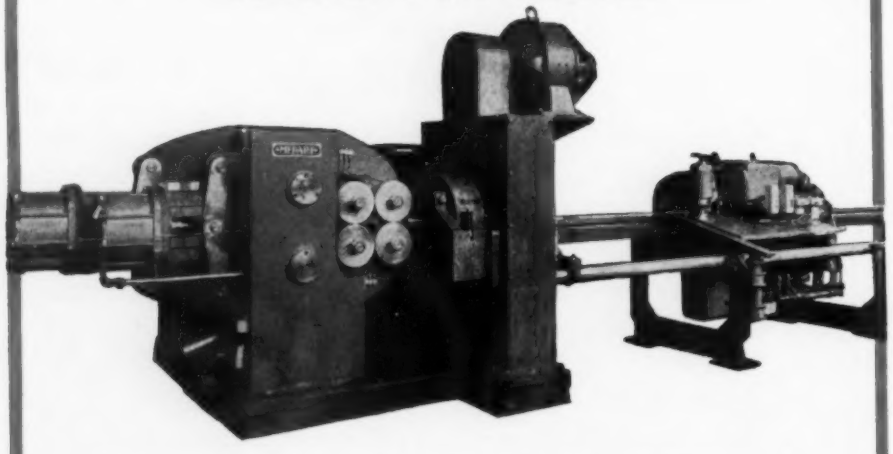
Triple Production or Better on Bar & Tube Turning!

MEDART

RFPD AUTOMATIC CENTERLESS BAR TURNERS

FOR BARS ¼" to 6" DIAMETER



▶ The unsurpassed production speeds of the RFPD Turner using carbide cutting tools—up to 12 ft. per minute—average from 3 to 4 times that of conventional turners by actual comparison.

▶ Material turned on this machine can be sold directly from the machine for "as turned" stock, put through the Medart two-roll rotary straightening, sizing and polishing machines for "turned and polished" stock, or given one pass through a centerless grinder for "ground" stock.

▶ The RFPD turning gives 100% material recovery with short, easy-to-handle chips.

▶ Direct-drive cutterhead, through single V-belt drive, is a single compact unit designed for either brazed tip or mechanically held carbide tools.

▶ Controls provide fully automatic push-button operation through entire cycle, and supplementary manual operation for setup. Both speeds and feeds are infinitely variable.

Many other cost-reducing, time-saving exclusives are offered in the RFPD Centerless Bar Turner.

Write For Illustrated Brochure

THE MEDART COMPANY 3535 De Kalb Street St. Louis 18, Mo.

(Continued from page 150)

chrome ore requirements. The new properties were purchased as a going company with complete equipment.

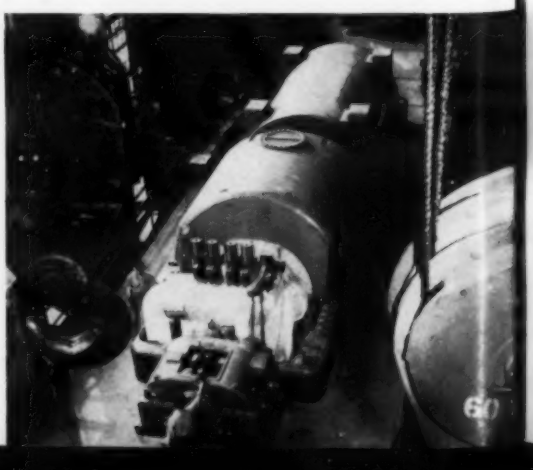
INDUSTRIAL TRUCK GROUP BROADENS SCOPE

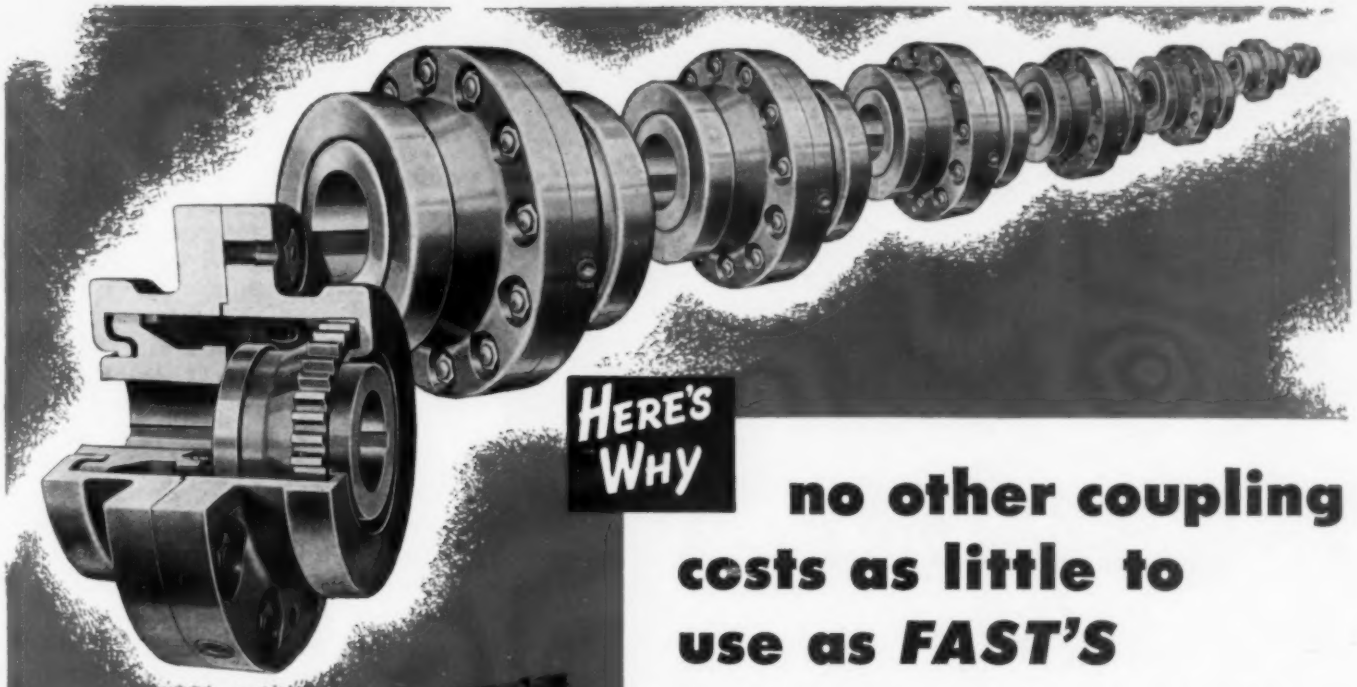
▲ At a special meeting of the membership of the Electric Industrial Truck Association held in Cleveland, Ohio, it was voted to open the association's membership to manufacturers of gas-powered industrial trucks and tractors. It also was voted to change the name of the organization to the Industrial Truck Association. The changes became effective as of March 12, 1951. The association will continue to maintain its headquarters offices at 3701 N. Broad Street, Philadelphia, Pa.

An announcement issued following the meeting stated that one reason for bringing manufacturers both of electric storage battery and gas-powered industrial trucks into one association was the belief that general industry could better be served. Also that a common source of information on the time-, cost-, and labor-saving potentialities of powered industrial trucks, now recognized as a fundamental tool of production, would be provided.

POWER GENERATOR

Workmen check for signs of vibration in new 60,000-kw turbo generator during trial run at U. S. Steel's South Chicago, Ill., plant. Reduction of vibration is one of the many steps taken during test period to ready generator for daily operation. The generator is the largest of its kind ever built for industrial power production. It is housed in a new ten-story addition to the No. 5 power station. Power generated by the new equipment will be transmitted to the company's sheet and tin mill at Gary, Ind.





HERE'S WHY

no other coupling costs as little to use as *FAST'S*

With Fast's Couplings you get the lowest coupling cost per year that modern engineering can provide—*because Fast's normally outlast the equipment they connect.* That means their cost can be spread out over 20 years or more!

As two users recently said:

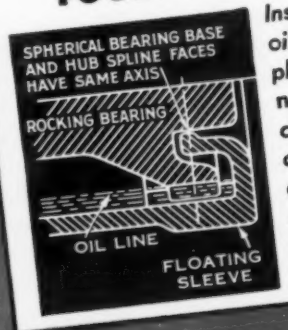
"We've had this Fast's Coupling since 1930 . . . and it's apparently going to last forever. [Wish] the other equipment caused as little trouble!" . . . "We have two Fast's Couplings . . . they are the only equipment so trouble-free we long ago forgot we had them!"

If you want lower costs, freedom from coupling shutdowns and dependable coupling engineering—specify Fast's. For complete details, mail the coupon for Fast's free catalog. Do it today!

RUGGED CONSTRUCTION:

Fast's still maintains its original design, without basic change or sacrifice in size or material. This assures you freedom from needless and expensive coupling failures.

FOOLPROOF DESIGN:



Instead of perishable oil seals, Fast's Couplings use a permanent metal-to-metal closure to keep dust out and oil in. Oil is always maintained at a safe level whether the Fast's is running or standing still.

FREE SERVICE:

When you specify Fast's Couplings you get Koppers' valuable free coupling service. If your application seems to need a special coupling, Koppers' engineers in many cases can easily modify a standard Fast's Coupling, and save you money!

MAIL COUPON TODAY FOR FREE CATALOG!

KOPPERS CO., INC., *Fast's Coupling Dept.,*
214 Scott St., Baltimore 3, Md.

Gentlemen: Send me Fast's Catalog which gives detailed descriptions, engineering drawings, capacity tables and photographs.

Name.....

Company.....

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City.....Zone.....State.....

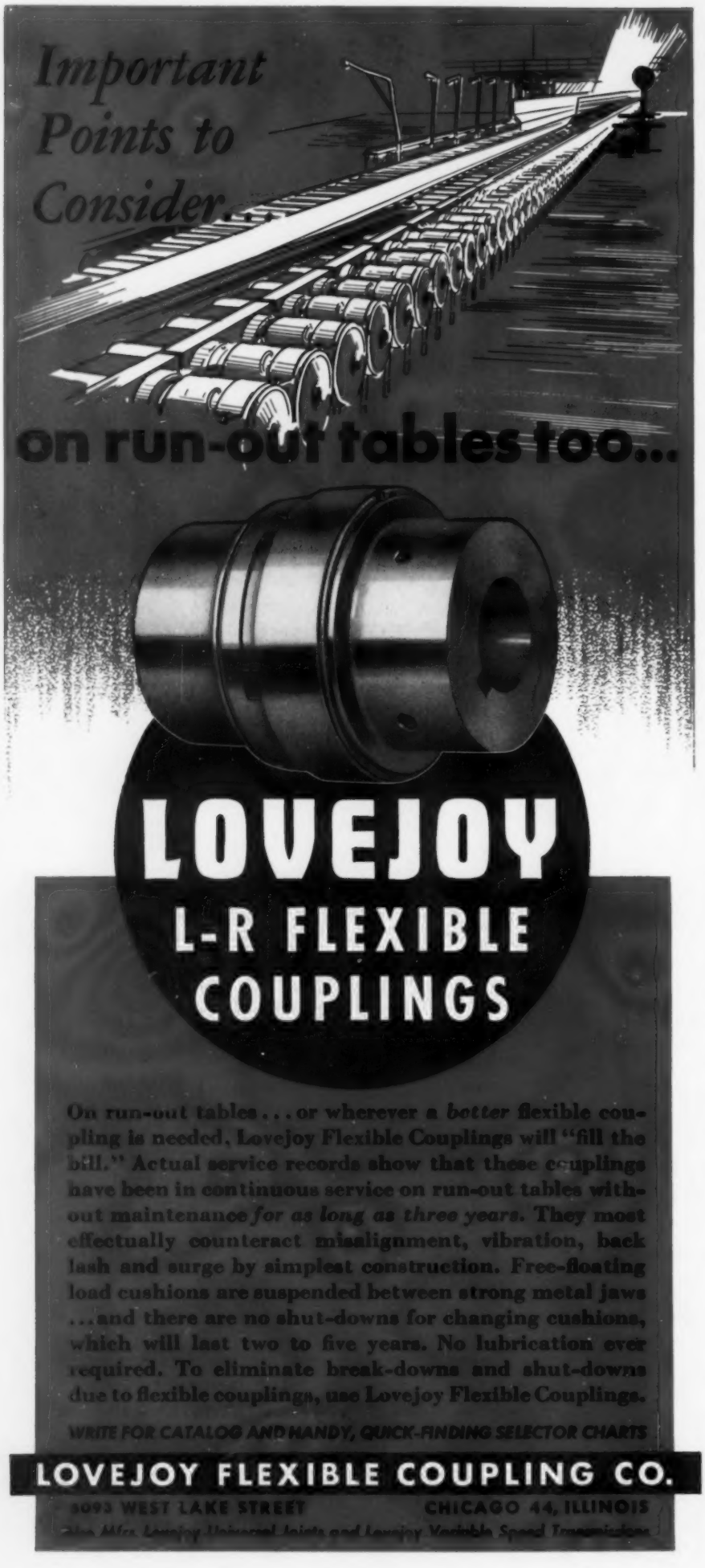
KOPPERS

FAST'S

THE ORIGINAL GEAR-TYPE

Couplings

INDUSTRY'S STANDARD FOR 31 YEARS


Important Points to Consider...
on run-out tables too...
LOVEJOY
L-R FLEXIBLE COUPLINGS
On run-out tables . . . or wherever a *better* flexible coupling is needed, Lovejoy Flexible Couplings will "fill the bill." Actual service records show that these couplings have been in continuous service on run-out tables without maintenance *for as long as three years*. They most effectually counteract misalignment, vibration, back lash and surge by simplest construction. Free-floating load cushions are suspended between strong metal jaws . . . and there are no shut-downs for changing cushions, which will last two to five years. No lubrication ever required. To eliminate break-downs and shut-downs due to flexible couplings, use Lovejoy Flexible Couplings.
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5093 WEST LAKE STREET CHICAGO 44, ILLINOIS
Also Mfrs. Lovejoy Universal Joints and Lovejoy Variable Speed Transmissions

RESISTANCE WELDERS ANNOUNCE CONTEST

▲ The Resistance Welder Manufacturers Association has called attention to the fact that entries in their prize paper contest must be mailed to arrive not later than July 31, 1951.

The contest provides an opportunity to those in industry or engaged in research laboratory work to compete for a first prize of $750, a second prize of $500 and a third prize of $250.

Papers emanating from a university source, (the author of which is either an instructor, graduate student or research fellow), are eligible to a $300 prize and a second prize in this classification of $200. Undergraduate students may submit papers for a $250 award. The contest is open to any one without restriction in the above categories located in the United States, its possessions and Canada.

For complete details regarding the subject matter of the papers and other contest rules write direct to the Resistance Welder Manufacturers Association, 1900 Arch Street, Philadelphia 3, Pa.

TIMKEN TO EXPAND STEELMAKING FACILITIES

▲ Timken Roller Bearing Co., Canton, Ohio, has announced a $5,503,000 expansion program. The expansion will involve both the melting and fabricating facilities. By the expenditure of $3,497,000 for land, buildings, 3 top-charge 80-ton capacity electric furnaces, additional soaking pit facilities and related items, Timken Steel and Tube Division will become exclusively a manufacturer of electric furnace alloy steels.

Due to limited land available at the Harrison Avenue melt-shop, this expansion will entail the replacement of the 3 open hearth furnaces in the melt shop with the new electric furnaces. This move will increase the company's capacity for producing electric furnace steel by approximately 277,000 ingot tons annually and will raise the total steelmaking capacity from 550,000 ingot tons to some 625,000 ingot tons annually. Percentage-wise, this means a 14 per cent increase in ingot tons annually and an 80 per cent increase in electric furnace steelmaking capacity.

A new feature of the electric fur-

nace will be the installation of an inductive stirrer developed in Sweden recently and being used in the United States for the first time. This new stirrer speeds up the chemical reaction in the melting charge, offers improved quality of steels and reduces the manual labor required in melting each charge.

KOPPERS TO BUILD PLANT AT FONTANA

▲ Koppers Co., Inc., has taken an option on 158 acres of land at Fontana, Calif., and contemplates construction of a plant there for the making of enamel pipe coatings and roofing materials.

The proposed site is adjacent to the Kaiser Steel Corp. plant and it is planned to use pitch made from tar obtained from the Kaiser Steel coke ovens, processing it into high-grade enamels for pipe coatings and various types of roofing materials. A contract with Kaiser providing an adequate supply of the pitch has been arranged.

MOVE MILL BUILDING — BUSINESS AS USUAL

▲ An interesting feature of the expansion program at the Corrigan-McKinney works of the Republic Steel Corp. at Cleveland, Ohio, is the moving and relocation of a two story brick office building. The building 41 x 120 ft is being moved intact by the Eichleay Corp. while service in the building goes on as usual.

CONNORS STEEL AWARDS CONTRACT TO RUST

▲ Connors Steel Co., Birmingham, Ala., a division of H. K. Porter Co., Inc., has let contracts for its $2,000,000 plant expansion.

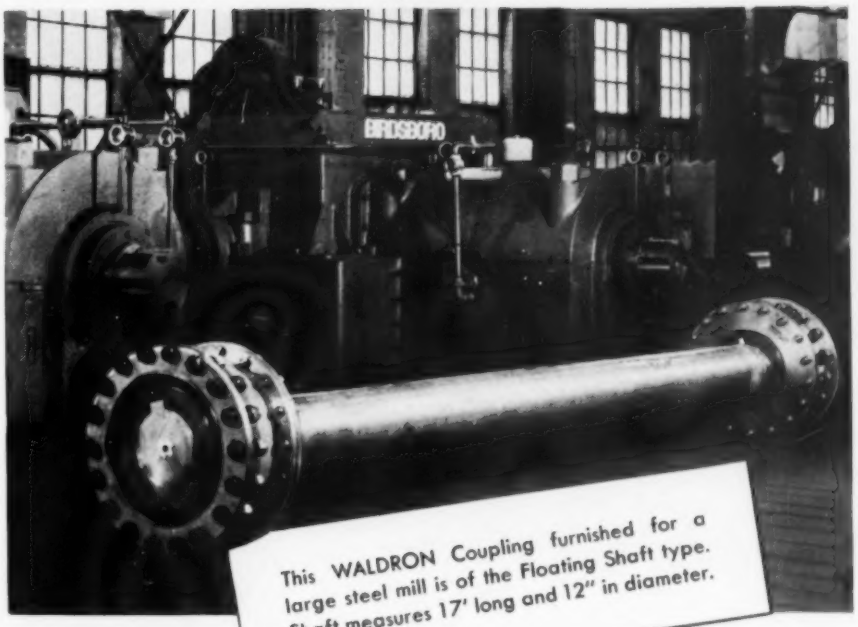
Rust Engineering Co. was awarded the contract covering the engineering and installation of the additional electric furnace for enlarged steel capacity, an additional billet heating furnace and the modernization of the present heating furnace. Also included are an 18 in. breakdown mill, new hotbed and coiling facilities, and enlargement of the laboratory and metallurgical facilities.

Treadwell Engineering Co. will furnish the breakdown mill, mani-

For The **RUGGED** *Jobs...*

WALDRON Improved Gear Type **COUPLINGS**

get the nod!



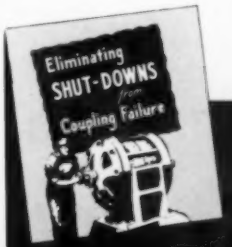
This WALDRON Coupling furnished for a large steel mill is of the Floating Shaft type. Shaft measures 17' long and 12" in diameter.

they are built for dependable service

...AND THEY GIVE IT!

Large or small—every WALDRON Coupling is designed and built with typical operating troubles in mind. Forty years of experience has taught WALDRON engineers the pitfalls to be avoided in producing a dependable coupling. The WALDRON design eliminates the usual sources of trouble; the WALDRON construction is simple and strong—forged steel parts, no welded sections, better lubrication.

The steadily growing preference for these sturdy WALDRON couplings in all major industries is a tribute to the quality and workmanship that goes into them.



Write for this Helpful Folder

explaining coupling features which give added insurance against coupling failure. No obligation.

JOHN WALDRON
CORPORATION
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Authorized Sales Representatives in Principal Cities

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STEEL HANDLING
BOTTLE NECKS

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...simplest mass handling method known!

Now... you can move 45,000-pound payloads of billets, bars, plate, in-process and finished steel *where* you want them *when* you want them... at a moment's notice!

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Now... you can prevent congestion in the mill... free more mill space for production operations... eliminate costly re-handling ... save time and money in getting out current orders!

How? With Ross Series 100... the *only* Carriers designed and built all the way through for rough, tough steel mill service... the *only* Carriers with that great reserve strength steel men demand. Self-loading and unloading, Ross Series 100 requires only a driver... and moves capacity loads at speeds up to 33 mph.

Don't overlook the outstanding advantages of the Ross Carrier Steel Handling Method... ASK STEEL MEN WHO *KNOW!* Get full details on Ross Series 100 Carrier... a 'phone call, wire or letter will do it.

Rely On ROSS

THE ROSS CARRIER COMPANY

Direct Factory Branches and Distributors Throughout the World

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pulator, and gear set. The motor drive will be produced by Westinghouse Electric Corp., while Pittsburgh Lectromelt Furnace Corp. will build the new 15-ton electric furnace. Bloom Engineering Co., Inc., designed the new reheating furnace and redesigned the old one. The 25-ton crane in the furnace building will be supplied by Whiting Corp.

When completed, Connors' capacity will be increased by 40 per cent over its present facilities.

WILLOUGHBY PLANT MAKES MILL PULPITS

▲ Wallace F. Schott, designer of the modern steel mill pulpit, formerly built by Lee Wilson Construction Co., has announced that several improvements are being incorporated in the latest units. Larger sub-assemblies are being made to reduce erection time, heat conduction has been further reduced and provisions made for concealed wiring. These pulpits and utility buildings are now being constructed by James Campbell Smith, Inc., Willoughby, Ohio.

REFRACTORIES PLANT EXPANDS CAPACITY

▲ Plans for approximately 12 million dollar expansion of the General Refractories Co. to be completed during 1951 were announced recently. The first phase of the building and expansion program will commence immediately. A $3,000,000 plant for the manufacture of silica refractories will be constructed on the Delaware River at Morrisville, Pa. The Baltimore, Md., works of the company is being enlarged 25 per cent. Improvements and new facilities will cost $2,000,000. In addition, a new plant will be constructed in Los Angeles at a cost of $1,000,000, which will enlarge West Coast facilities by 100 per cent. Other expansion plans are yet to be announced.

LEWIS BUILDS MILL FOR GREEK STEEL FIRM

▲ Lewis Foundry & Machine division of Blaw-Knox Co. has completed a sheet mill modernization program for the Sheet Steel and Tin Plate Co. Ltd., of Piraeus, Greece. Included in the project was the supply of modern

STOP

FREE SURVEY: Place your rust problems in the hands of a RUST-OLEUM specialist. He will survey your plant for all rust problems, submit detailed recommendations, and make specific tests.

You can stop rust with RUST-OLEUM! An exclusive formula proved in a wide range of industrial and marine applications for more than 25 years. Its tough, pliable film dries to a firm rust-resisting coating that protects against rust—cuts maintenance costs—adds years of use to many metal surfaces, indoors and outdoors.

RUST-OLEUM may be applied over rusted surfaces without removing all the rust, assuring substantial savings in preparation time... It is only necessary to remove all the rust scale and loose rust.

Prompt delivery from Industrial Distributor stocks in principal cities. See *Sweets* for complete catalog and nearest source of supply, or write for complete literature on your company letter head today!

Beautifies AS IT PROTECTS

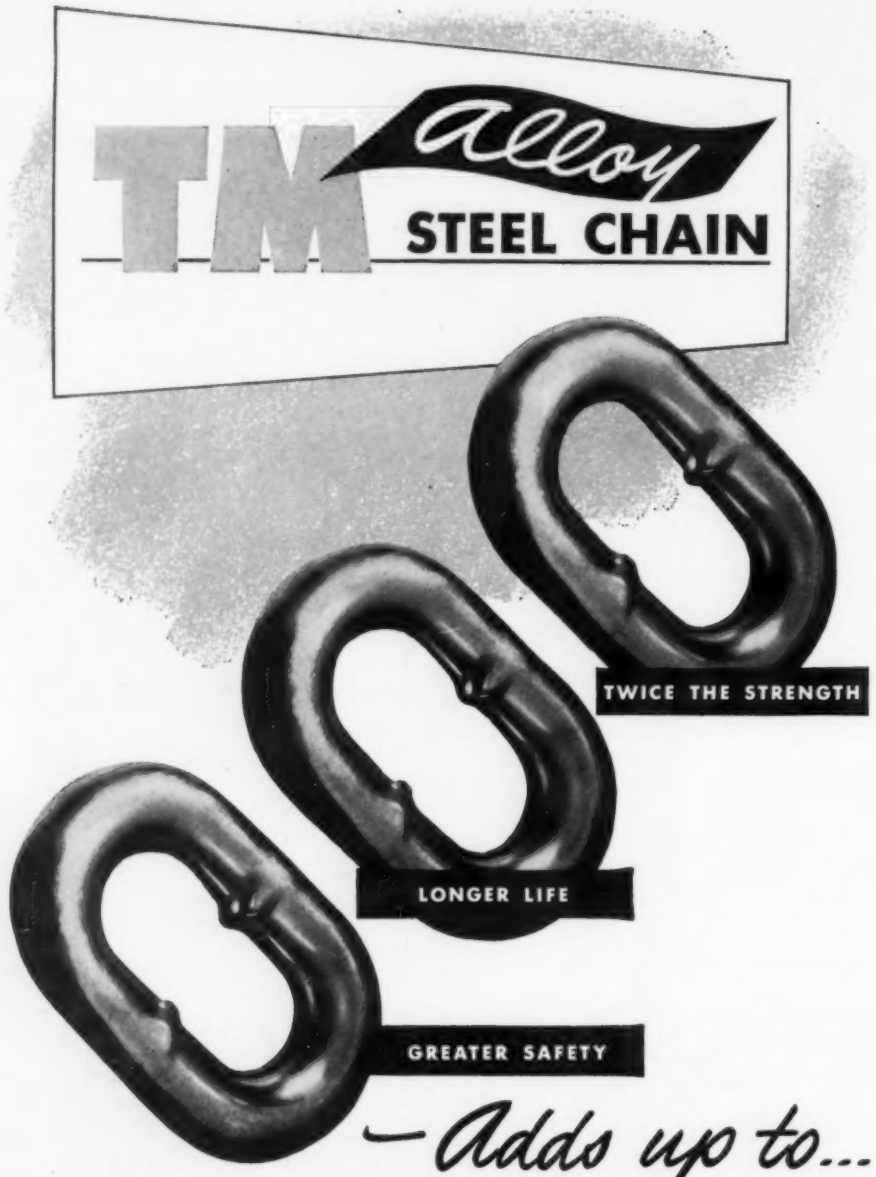
Available in many **COLORS,** aluminum and white

RUST

RUST-OLEUM CORPORATION

2411 Oakton Street, Evanston, Illinois

"Rigid Economy, Men"



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Lower Chain Costs!

Reverse rising chain costs with TM Alloy Steel Chain. It's super safe. It *stays on the job five to fifteen times longer*—has twice the tensile strength of wrought iron chain. TM Alloy Steel Chain is completely heat-treated for link to link uniformity. Extreme toughness and great resistance to shock, grain growth and work-hardness eliminate periodic annealing costs. Call your mill supply distributor today for more details or write Dept. 5, for Bulletin 12A.

S. G. TAYLOR CHAIN COMPANY
HAMMOND, INDIANA

This Registration Ring bears the chain's serial number. It's your assurance of thorough testing and inspection before shipment.

TAYLOR MADE
A GREAT NAME IN
Chain SINCE 1873

Lewis control equipment and accessories such as conveyors, tables, doublers and walking beam furnaces.

FAIRLESS CONTRACTS FOR BLAST FURNACES

▲ United States Steel Co. announced the award of a contract to the Arthur G. McKee and Co. of Cleveland, Ohio, for designing, furnishing and erecting two blast furnaces at the Fairless works of U. S. Steel at Morrisville, Pa. The contract calls for the complete erection of the two furnaces and all auxiliary equipment. The furnaces will have 28-ft hearths and a daily capacity of 1500 tons of pig iron. The facilities contracted for include three stoves for each furnace, a cast house, gas cleaning equipment, and skip and bell hoists for filling the furnaces.

RUST FURNACES SOLD TO ITALIAN STEEL FIRM

▲ Design and complete engineering services for two slab reheating furnaces to serve a hot strip mill of Societa Italiana Acciaierie di Cornigliano at Genoa, Italy, are being furnished by the Rust Furnace Co.

Both units will be Rust continuous slab reheating furnaces of the pusher type, modern in every respect, with a capacity of 65 metric tons per hour each.

Rust will also furnish recuperators, and combustion and control equipment for the furnaces, which will be zone-controlled and triple-fired with either fuel oil or a mixture of blast furnace and coke oven gas.

GALVANIZERS TO MEET IN ST. LOUIS, MO.

▲ The Galvanizers Committee, which is sponsored by the American Zinc Institute, will hold its twenty-fifth meeting in St. Louis, Mo., on May 21-22, 1951, according to Chairman L. C. Flickinger, of Youngstown Sheet & Tube Co.

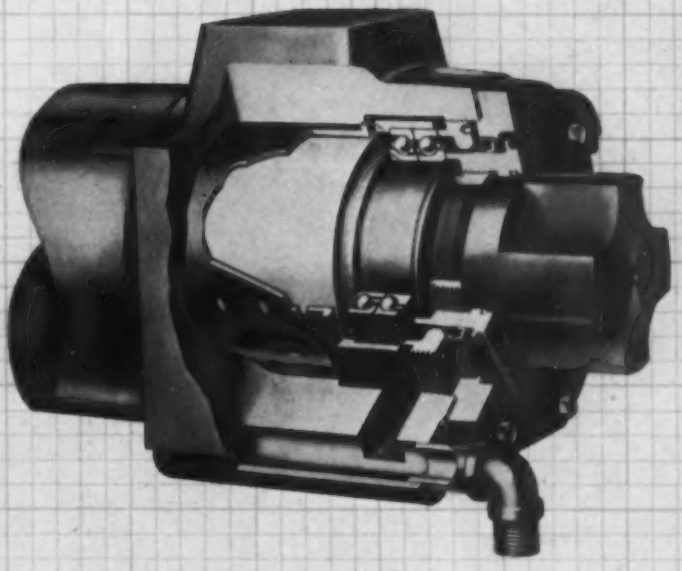
W. L. Diehl, assistant superintendent of galvanizing at the Steubenville, Ohio, plant of Wheeling Steel Corp., heads the program committee for the occasion, which will be held at the Hotel Statler coincident with the annual meeting of the American Zinc Institute previously announced.

...team up for efficient performance

Morgoil and Torrington Roll Neck Bearings work together to handle tremendous loads and are used in a wide variety of mill applications —from reducing steel or cold brass slabs to rolling aluminum foil to .00025" thickness.

These roll neck bearings assure combined capacity for high radial and thrust loads... maintain close tolerances in the rolled product at higher speeds. The Torrington Thrust Bearings provide for exact pass alignment when rolling formed sections.

To help improve the operation of your equipment Torrington engineers will be glad to apply their wide experience in bearing design and manufacture.



THE TORRINGTON COMPANY

South Bend 21, Ind. • Torrington, Conn.

District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON BEARINGS

SPHERICAL ROLLER • TAPERED ROLLER • STRAIGHT ROLLER • NEEDLE • BALL • NEEDLE ROLLERS

The Toughest Motors Ever Built...

RELIANCE D-C.

One of the most modern brass mill runout tables in operation today.

Fastest continuous pipe mill in the world.

Portion of the biggest seamless tube mill ever built.

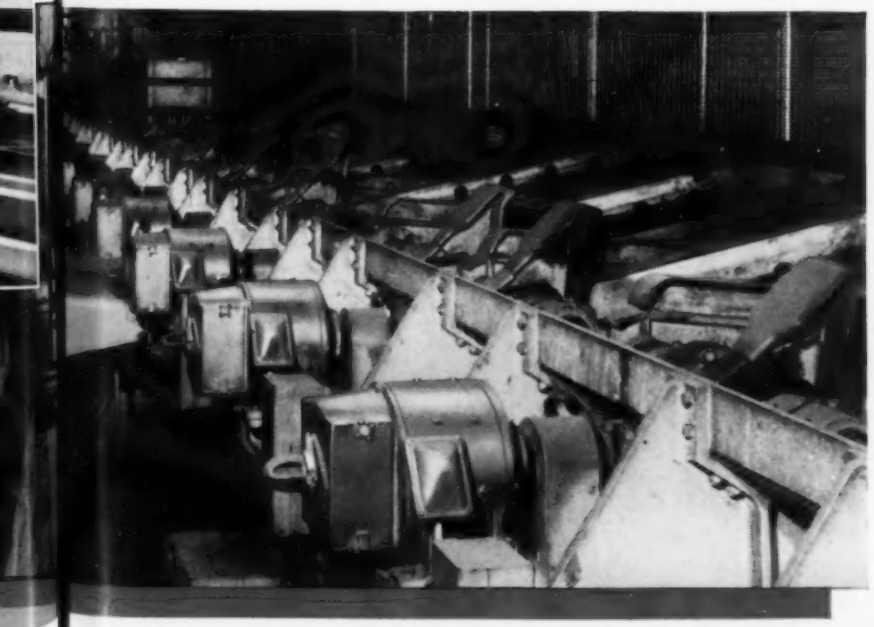
World's widest aluminum strip mill.

MOTORS for Runout Tables

★ ★ ★

25 YEARS of Reliance experience makes them the best you can use for the job!

Strongest proof of the outstanding performance and dependability of Reliance Motors lies in the fact that you find more of them on runout tables than any other make. Whether the installation calls for D-c. Motors with direct coupling, as gearmotors or as floating motors, the Reliance experience of over a quarter of a century in powering runout tables assures you the *best* motors you can use to keep materials moving. In supplying completely engineered drives for operation of runout tables and conveyors, Reliance Application Engineers effectively combine their practical "know-how" with that of equipment manufacturers.



RELIANCE
TYPE 'T' HEAVY DUTY
D-C. MOTORS

THE TOUGHEST MOTORS EVER BUILT!

Reliance D-c. Motors in runout table service are proving Type 'T' as "The Toughest Motors Ever Built". Write today for Bulletin C-2001 that contains data to select the right D-c. motor for any job.

Sales Representatives in Principal Cities

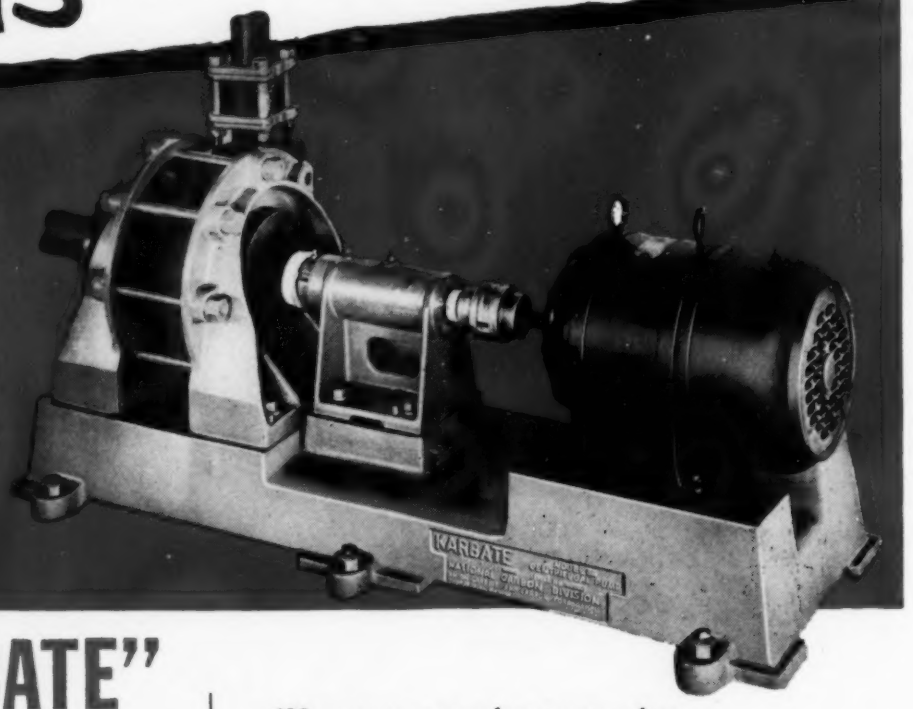
RELIANCE ELECTRIC AND ENGINEERING CO.

"Motor-Drive is More Than Power" • 1084 Ivanhoe Road, Cleveland 10, Ohio

NOW SAVE 2 WAYS

not only by—REDUCED PRICES
but also thru—
LOWER MAINTENANCE COST

To the savings made by the reduction in "Karbate" brand impervious graphite pump prices (up to 33%), add the all-important factor of *very low annual maintenance cost.* Our records show some pumps in service for years, requiring practically no replacement parts.



Specify "KARBATE" BRAND

Impervious Graphite Corrosion Resistant

PUMPS

HERE'S WHY—

- Case and Impeller are of "Karbate" impervious graphite — they do not corrode.
- Stainless Steel Shaft, where exposed to corrosive fluids, protected by "Karbate" impervious graphite.
- "Karbate" impervious graphite rotary seals* are regular equipment — included in basic pump price. They are not "extras".
- No stuffing gland to require packing — a single, occasional adjustment of the "Karbate" rotary seal replaces this cost.

Other NATIONAL CARBON products

*Now, even at new low pump prices, "Karbate" rotary seals have been improved. Teflon is used to gasket the seal to the shaft and the gasket is adjusted, independently of pressure, on the seal faces.

OTHER FEATURES:

- All-purpose application
- Freedom from product contamination
- Excellent corrosion resistance
- Rugged construction
- Low maintenance — minimum servicing and replacement of parts

The term "Karbate" is a registered trade-mark of

NATIONAL CARBON DIVISION
UNION CARBIDE AND CARBON CORPORATION
30 East 42nd Street, New York 17, N. Y.
District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
In Canada: National Carbon Limited, Toronto 4

BLAST FURNACE LININGS • BRICK • CINDER NOTCH LINERS • CINDER NOTCH PLUGS • SKIMMER BLOCKS • SPLASH PLATES • RUNOUT TROUGH LINERS • MOLD PLUGS • TANK HEATERS

Personnel News...

L. F. Reinartz was elected vice president in charge of special operating development at Armco Steel Corp., Middletown, Ohio. **G. D. Tranter** was named manager of the Middletown division; **D. S. Holstein** became general superintendent in charge of rolling and processing at the Middletown division; and **O. E. Clark** became general superintendent in charge of blast furnaces and melting at that division.

Denver L. Hykes, formerly assistant superintendent—blast furnaces, Pittsburgh, Pa., works, of Jones and Laughlin Steel Corp. has been appointed superintendent—blast furnaces, coke ovens, and dock at the corporation's Otis works, Cleveland, Ohio.

James R. Lowe was appointed assistant superintendent—blast furnaces, Pittsburgh, Pa., works, to fill the vacancy at Jones and Laughlin Steel Corp. created by Mr. Hykes' appointment to Otis works.

Carl M. Riefkin has been elected vice president of Newport Steel Corp. Mr. Riefkin has been associated with the steel operations at Newport, Ky., for the past twenty-seven years.

Wilbur B. McLaren has been appointed superintendent of personnel at the Indiana Harbor, Ind., works of Inland Steel Co. Mr. McLaren was director of industrial relations at the Willow Run plant of the Kaiser-Frazer Corp. for five years, and before that was with the Ford Motor Co.

Frank J. Mack was elected treasurer of the Fawick Airflex Co., Cleveland, Ohio.

Brookes D. Billman has been appointed assistant director of personal relations of Armco Steel Corp., Middletown, Ohio. For a number of years Mr. Billman has been assistant to the manager of Armco's Butler, Pa., works.

Frank U. Naughton, Jr., was named manager of the eastern sales division of Hyatt Bearings division, General Motors Corp., Harrison, N. J. Mr. Naughton, a sales engineer for Hyatt since 1924, served in the Philadelphia, New England and Southeastern territories. He succeeds **W. L. Iliff** who died February 3.

William R. Wilkinson has been appointed vice president for sales and **Kenneth W. Huffine** has been appointed vice president for production, for Johns-Manville Corp., New York, N. Y.

Joseph H. Matulis has been named industrial manager of Minneapolis-Honeywell Regulator Co.'s, Chicago, Ill., branch, **Willard Smith** was named industrial manager of the Pittsburgh, Pa., branch, and **Joseph H. Bowman** was made industrial manager of the Buffalo, N. Y. office.

Leslie M. Cassidy was elected chairman of the board and chief executive officer of Johns-Manville Corp., New York, N. Y., and **Adrain R. Fisher** was appointed president. Mr. Cassidy succeeds to the post left vacant by the death on February 26, of **Lewis H. Brown** who had been chief executive officer of Johns-Manville Corp. since 1929, first as president and, from 1946, as chairman of the board. Mr. Fisher succeeds Mr. Cassidy, who became president of Johns-Manville Corp. on the retirement of **R. W. Lea** on January 31.

Harry G. Andersen, heretofore district sales engineer for Link-Belt Co. at Milwaukee, Wis., has been appointed district manager at Birmingham, Ala., with headquarters in the Comer Building, 2100 Second Avenue N.

J. S. Smith was named director of purchases for Wagner Electric Corp., St. Louis, Mo. Mr. Smith was born April 7, 1902 in Pittsburgh, Pa. and moved with his family to St. Louis, Mo., in 1907. After graduating from high school he went to work in the research department of Wagner Electric in 1919. During the next five years Mr. Smith worked his way up to foreman in charge of testing intermediate motors, and at the same time attended night classes at Washington University in St. Louis. He received his certificate of electrical engineering in 1924, and the same year was transferred to the sales department. From 1926 to 1936 he was a field engineer for the company, first at Detroit, next at Toledo, and finally at Pittsburgh. In 1936 he was appointed a special representative to the steel industry, with headquarters in Pittsburgh, and held that position until 1942, when he returned to St. Louis as manager of the industrial sales department.

William E. Harvey was named vice president in charge of production for Speer Carbon Co. and its

L. F. REINARTZ

G. D. TRANTER

D. S. HOLSTEIN

J. S. SMITH

wholly owned subsidiary, International Graphite and Electrode Corp., both in St. Marys, Pa.

R. S. Gruver, assistant vice president of operations

R. S. GRUVER

of Armco Steel Corp., Middletown, Ohio, has been temporarily appointed special assistant to the president.

John E. Carroll, general sales manager of American Hoist and Derrick Co., was elected vice president of sales.

L. F. McCaffrey has joined Empire Steel Corp., Mansfield, Ohio, in the capacity of assistant general superintendent. He will also be in charge of the new hot strip mill installation that is now under construction. Mr. McCaffrey formerly was connected with Republic Steel Corp., Steel Co. of Canada, Ltd., Algoma Steel Corp. and recently left the National Steel Co. of Brazil to join the Empire Steel.

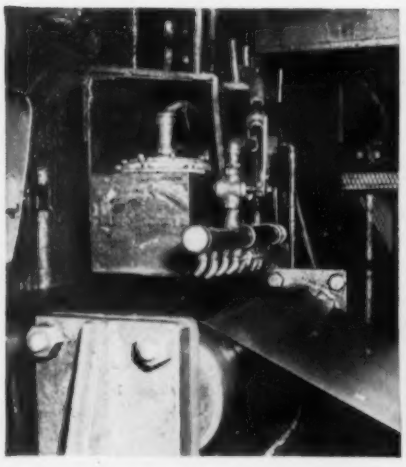
L. F. McCAFFREY

Richard Moyer, heretofore general superintendent at the Pershing Road plant in Chicago, Ill., of Link-Belt Co., has been appointed general manager of the north central division, with headquarters at the company's plant in Minneapolis, Minn. **Fred B. Skeates,** heretofore personnel manager at the Pershing Road plant, has been appointed general superintendent to succeed Mr. Moyer.

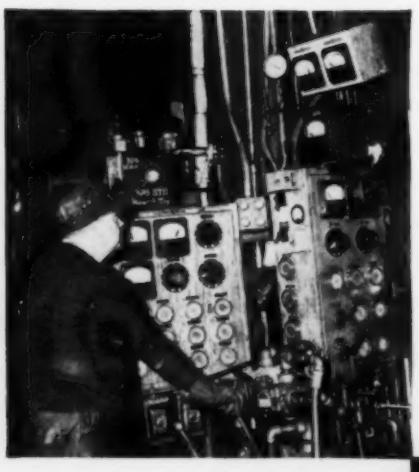
Edwin Vereeke was named to the position of sales

GE X-RAY THICKNESS GAGE helps Inland Steel

BOOST ON-GAGE TONNAGE



In a fraction of a second after strip passes the gage head, deviations, if any, show up on indicator.



Operator watches deviation indicator and makes mill adjustments when strip is off-gage.

C. R. McLeod, Asst. Supt. Cold Strip, says "Our G-E gage gives us the dependable, accurate, high-speed strip-gaging method we need. It's the best we have found for our operation."

After extensive mill modernization, speed on Inland's #5 tinplate mill was upped from 1200 fpm to 4000 fpm. This made their old gage lose accuracy and require excessive maintenance. A General Electric X-Ray Gage was then installed and has proven to be:

RUGGED — The gage operates 18 turns a week with a minimum of maintenance during rolling time.

ACCURATE — Inland now holds closer tolerances at 4000 fpm than they did with their old gage at 1200 fpm.

SIMPLE — On continuous and reversing mills, the gage can be set-up in seconds for new schedules with one simple adjustment.

For more facts call your G-E salesman or write to Sec. 687-69 for bulletins GEC-471 and GEC-485. Apparatus Dept., General Electric Company, Schenectady 5, N. Y.

687-69

GENERAL ELECTRIC

INTEGRATED PROCESS CONTROL assures quality of

Ohio Rolls

SHAPING METAL FOR ALL INDUSTRY

Select from any of these eleven types of Ohio Steel and Iron Rolls:
Carbon Steel Rolls
Ohioloy Rolls
Ohioloy "K" Rolls
Holl-O-Cast Rolls
Chilled Iron Rolls
Denso Iron Rolls
Nickel Grain Rolls
Special Iron Rolls
Nioloy Rolls
Flintuff Rolls
Alloy Chilled Iron Rolls

At Ohio Steel a team of specialists, working as a closely-knit unit, supervises production of your rolls. This coordinated talent (metallurgists, chemists, engineers, inspectors) brings you better rolls faster. We refer to these experts and their knowledge of foundry practice as INTEGRATED PROCESS CONTROL.

THE OHIO STEEL FOUNDRY CO. LIMA, OHIO

PLANTS AT LIMA AND SPRINGFIELD, OHIO

manager, with charge over all sales and advertising, for Heil Process Equipment Corp., Cleveland, Ohio. Mr. Vereeke has been with the Heil Corp. in the capacity of district sales supervisor. Also announced are the appointments of **Robert Peters** as sales engineer for the area west of Cleveland, and **Ken Grader** as sales engineer in charge of the area east of Cleveland.

Robert R. Person has been appointed staff assistant to the manager of manufacturing of the General Electric Co.'s large apparatus division at Schenectady, N. Y.

John Mikulak has been appointed assistant to the vice president in charge of manufacturing of Worthington Pump and Machinery Corp., Harrison, N. J.

Chester W. Schweers has been named director of sales of Allis-Chalmers general machinery division, in Milwaukee, Wis.

Alfred Fleissig was named director of purchases and contracting for Hydropress, Inc., New York, N. Y., and its subsidiaries.

George B. Isett was named as sales and service engineer for Brooks Chemicals, Inc. in the Chicago, Ill. district.

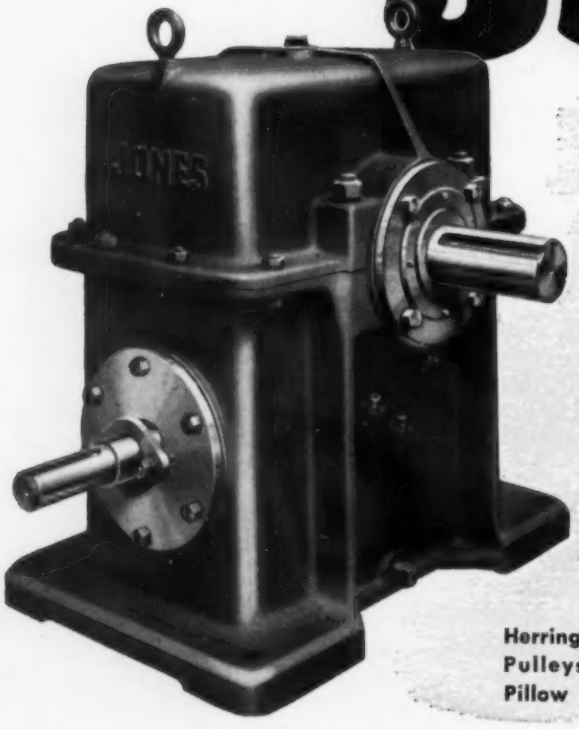
Jay B. Tracy, Sr., has been appointed manager of railroad sales and service of the General Refractories Co., Philadelphia, Pa. **Franklin D'Olier, Jr.,** has been appointed director of advertising and public relations.

T. M. Evans of Pittsburgh has been elected to the board of directors of the White Motor Co., Cleveland, Ohio. Mr. Evans is president of H. K. Porter Co., Inc.

Edwin H. Gott has been appointed general superintendent of the Youngstown, Ohio, district operations of United States Steel Co. He succeeds **John W. Humphrey** who died suddenly on March 17. Mr. Gott comes to Youngstown from the company's South works in Chicago, Ill., where he has been assistant general superintendent. In his new position he will supervise operations of the company's Ohio Works at Youngstown and McDonald Works in McDonald, Ohio.

EDWIN H. GOTT

Jones



WORM GEAR SPEED REDUCERS

A right angle unit built for heavy duty performance in any industry. The worm can be above or below the gear. Shafts are single or double extended for coupling connections or chain or gear drives.

They are built in ratios from 4 to 1 to 90 to 1 and in capacities from ¼ to 100 H.P.

Bulletin No. 68 covers selection tables and dimensions.

W. A. JONES FOUNDRY & MACHINE CO.
4431 W. Roosevelt Rd., Chicago 24, Ill.

Since 1890 Jones In the Service of Industry

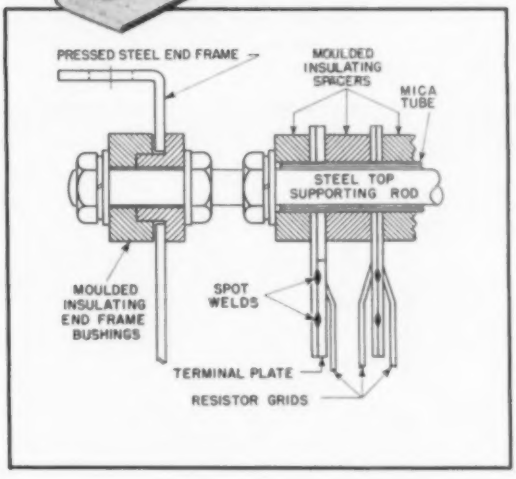
Herringbone — Worm — Spur — Gear Speed Reducers
Pulleys · Gears · V-Belt Sheaves · Anti-Friction
Pillow Blocks · Friction Clutches · Flexible Couplings

Double Insulation To Ground

The supporting rods used in EC&M TAB-WELD Resistor Sections are insulated from the steel end-frames by interlocking moulded bushings. Mica tubes are placed over the supporting rods to insulate the individual grids.

The assembled grid-stack is clamped by nuts located on the supporting rods *inside* the end-frames, making it possible to maintain *accurate mounting-hole* dimensions. End-frames are independently clamped.

In low-ampere-capacity sections, requiring a center supporting rod, interlocking spacers insulate and hold the grids firmly. These spacers have high heat-resisting properties.



OTHER IMPORTANT FEATURES WORTH REMEMBERING

1. Corrosion-resistant alloy steel.
2. Negligible resistance change.
3. Same height, width, length.
4. Same size grid throughout.
5. Convenient tap-shifting.
6. Non-breakable.

specify **EC&M Bulletin 942 *TAB-WELD* Plate Resistors**

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO

"YOU BUY 1 BOX . . . OR 10,000 BOXES . . . AT THE SAME LOW FLAT PRICE PER BRUSH!"

BECAUSE WE'VE STANDARDIZED NATIONAL TRADE-MARK CARBON BRUSHES

FOR STEEL MILL EQUIPMENT!

YOU PAY the same low, flat price regardless of how many brushes you buy, providing you buy one box or multiple thereof. You get fast delivery because these brushes are kept in stock in large supply. You get better quality because of manufacturing refinements made possible by mass production economies. You get a brand new package — sturdy, attractive, easy to store and handle.

Why is this possible? Because we have STANDARDIZED "NATIONAL" brushes for popular motors and generators. We have picked the most versatile, the most widely used, the best brushes in the field. We have made them applicable to an even greater number of jobs — made them better in many ways — and we are now making these brushes in quantity. The list of STANDARDIZED steel mill brushes follows:

FOR MILL TYPE MOTORS

NC 20-4800	2¼ x 1½ x ⅝ Grade AX-5	—For GE Type "MD"; West. "MC" & "K"
NC 20-5600	2¼ x 1¾ x ⅝ Grade AX-5	—For GE Type "MD"; West. "MC" & "K"
NC 24-4800	2½ x 1½ x ¾ Grade AX-5	—For West. Type "MC"
NC 24-5600	2¼ x 1¾ x ¾ (⅜-⅜)	—"Plytek" Brush Grade AX-5— For GE Type "MD"
NC 24-6400	2½ x 2 x ¾ Grade 401	—For West. Type "MC" & "K" Also Crocker-Wheeler "EW", "FW" & "SW".

FOR GENERAL PURPOSE D. C. MOTORS AND GENERATORS

NC 12-3202	1¾ x 1 x ⅜ Grade 255	—For West. Type "SK"
NC 12-4001	1¾ x 1¼ x ⅜ Grade 255	—For West. Type "SK"
NC 20-4002	1¾ x 1¼ x ⅝ Grade 255	—For West. Type "SK"
NC 12-5610	2½ x 1¾ x ⅜ Grade SA-35	—For West. Tandem Holders
NC 16-5603	2½ x 1¾ x ½ Grade SA-35	—For West. Tandem Holders
NC 12-4003	2 x 1¼ x ⅜ Grade 255 (15/15 Bevel)	—For GE Type "CD"
NC 16-3205	2 x 1 x ½ Grade 255 (15/15 Bevel)	—For GE Type "CD"
NC 12-4802	2¼ x 1½ x ⅜ Grade SA-35	—For "Toe-to-Toe" Holders
NC 16-4804	2¼ x 1½ x ½ Grade SA-35	—For "Toe-to-Toe" Holders

FOR ELECTRIC WELDERS

NC 16-2001	1¼ x ⅝ x ½ Grade SA-50
NC 16-4801	1½ x 1½ x ½ Grade 255
NC 20-4801	1¾ x 1½ x .618 Grade 255
NC 20-4802	1¾ x 1½ x .618 Grade SA-45

The terms "National", "Plytek" and the Three Pyramids Device are registered trade-marks of

NATIONAL CARBON COMPANY • **Division of Union Carbide and Carbon Corporation**

30 EAST 42ND STREET, NEW YORK 17, N. Y.

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco • In Canada: National Carbon Limited, Toronto 4

Herman Sandberg was appointed superintendent of the mechanical department at Republic Steel Corp.'s Cleveland district. Mr. Sandberg held a similar position at Republic's Buffalo, N. Y., district before his Cleveland appointment. A native of Sweden, Mr. Sandberg has been with Republic or predecessor companies in supervisory positions since 1914. He has been a member of Republic's mechanical maintenance committee for 16 years.

HERMAN SANDBERG

Robert J. Stoddard was named vice president of engineering for American Hoist and Derrick Co., St. Paul, Minn.

Thomas C. Beattie was named general superintendent of Fairless works of National Tube Co. Mr. Beattie will manage all operations of the new pipe mills which are being installed by National Tube Co. near Morrisville, Pa.

THOMAS C. BEATTIE

R. W. Brisky has been appointed representative for Electric Products Co. in Grand Rapids, Mich.

O. P. Proudfoot has been named manager of the Cleveland, Ohio, district sales office of Cutler-Hammer, Inc. Mr. Proudfoot succeeds **R. J. Eckstein** who passed away February 14.

Heroult

ELECTRIC MELTING FURNACE

. . . as ever, the dependable furnace for the production of high-grade stainless, alloy and rimming steels.

Removable roof of new design now available for the larger furnaces.

AMERICAN BRIDGE COMPANY

General Offices: Frick Building, Pittsburgh, Pa.

Contracting Offices in New York, Philadelphia, Chicago, San Francisco and other principal cities
United States Steel Export Company, New York

USS

AMERICAN BRIDGE

UNITED STATES STEEL

Up to 22 times more operations without re-lubricating

HOMESTEAD-REISER

Self-Seald

LUBRICATED PLUG

VALVES

TEST RECORD

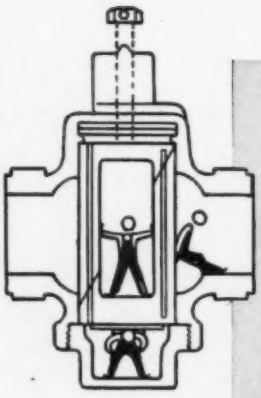
VALVE	NO. OF OPERATIONS Without RE-LUBRICATING
VALVE "A"	5
VALVE "B"	33
HOMESTEAD-REISER VALVE	**110**

Each valve assembled with the manufacturer's recommended lubricant. Test made on 75 lb. air pressure.

This comparative test of a Homestead-Reiser Valve and two other well-known lubricated plug valves showed that the Homestead-Reiser Valve remained drop-tight through twenty-two times more operations than Valve "A" without re-lubricating, and through three times as many operations as Valve "B". That means that Homestead-Reisers require less attention, and give greater economy of lubricant.

Prove the superiority of Homestead-Reiser Valves to your own satisfaction, by installing a few in your plant, side by side with any other lubricated plug valve. They may be had in both semi-steel and cast-steel, sizes ½" to 12" for steam working pressures to 150 pounds, or oil-water-gas to 200 pounds.

Write for new catalog 39-5, and for prices on your requirements.



"Self-Seald" MEANS

. . . that in addition to a full-port lubricant seal, the wedge-action of the plug under line pressure forces the finished surfaces of the plug outward, and constantly presses them against the seating surfaces of the body, thus keeping them always in intimate contact. The plug automatically adjusts itself for wear, assuring extra long life, maximum leakless service, and lubricant economy.

HOMESTEAD VALVE MANUFACTURING CO.

"Serving Since 1892"

P. O. Box 21 **CORAOPOLIS, PA.**

Donald I. Bohn, chief electrical engineer of the Aluminum Co. of America, Pittsburgh, Pa. was awarded the 1950 Benjamin G. Lamme gold medal by the American Institute of Electrical Engineers.

Mr. Bohn, a native of Chicago, Ill., won the medal "for his pioneering development and application of electrical equipment for controlling rectifying systems in the production of aluminum." He has been granted many patents in this connection and for other inventions.

Presentation of the medal will be made at the Summer General Meeting of the Institute at Toronto, Canada, June 25-29. Mr. Bohn is the 22nd recipient of the medal which is awarded annually to an Institute member "who has shown meritorious achievement in the development of electrical apparatus or machinery."

Mark W. Cresap, Jr., management consultant, has joined Westinghouse Electric Corp., Pittsburgh, Pa., as a vice-president and assistant to the president. Mr. Cresap is a co-founder of the New York and Chicago management consultant firm of Cresap, McCormick and Paget.

Henry R. Michel has been appointed assistant to the vice-president in charge of purchases and traffic for the Westinghouse Electric Corp., Pittsburgh, Pa. In his new position, Mr. Michel will be assigned to the Washington, D. C. office of Westinghouse, with responsibility for all matters pertaining to purchasing as it is affected by governmental regulations.

Robert Logie has been elected president of the National Roll and Foundry Co., Avonmore, Pa. Mr. Logie, who joined National Roll in 1947, served as executive vice-president.

ROBERT LOGIE

Guy R. Shoemaker was named manager of marketing research for General Electric Co.'s mid-states apparatus district. Mr. Shoemaker will be located at district headquarters in St. Louis, Mo.

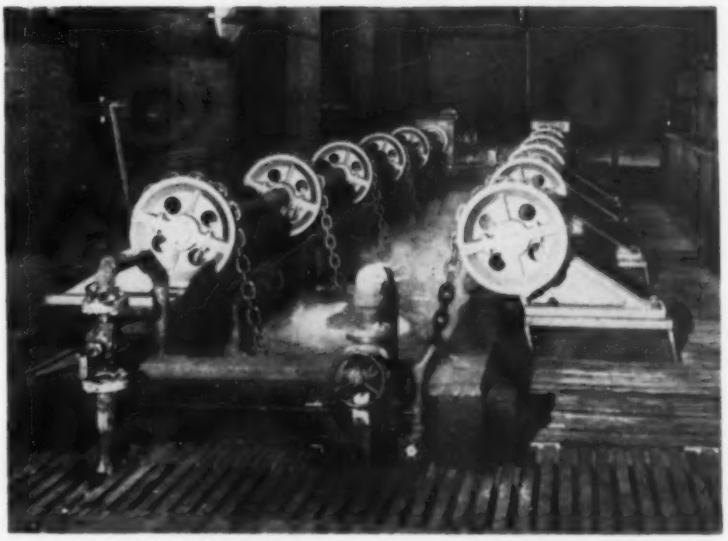
Paul Reeves was appointed director of sales for Timken Roller Bearing Co., Canton, Ohio. **Seward T.**

"First things come first," states an old saying, and that's why this Weldco Mechanical Pickler is an important addition in the Cold Drawn Division of an Eastern Ohio steel mill. For the success of the cold-drawing operation depends on the proper pickling of the bars, and this pickling-descaling job comes "first."

The Pickler shown here is a 7½-ton Mechanical Bar Pickler in a floor-level tank 5′ x 5′ x 43′. This equipment pickles 120 tons per turn—rounds, squares, hexagons, and flats. The spreaders, chains, and foundation bolts are made of long-lasting, corrosion-resisting Monel.

Production records in this Ohio steel plant show

Cuts Pickling and Drawing Costs



In Major Ohio Steel Plant

a uniform, complete descaling operation, reduced pickling and drawing costs, longer die life, and fewer rejects at the drawbench . . . . all of which indicate a sound investment in pickling equipment that will soon pay for itself.

Weldco Mechanical Picklers are also available for pickling coils, tubing, and sheets . . . can be built to any capacity. Write today for complete information and descriptive literature.

THE YOUNGSTOWN WELDING & ENGINEERING COMPANY

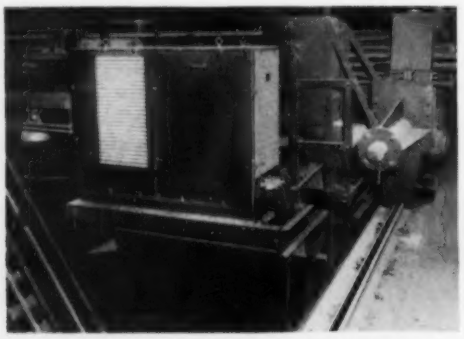
3700 OAKWOOD AVENUE . . . YOUNGSTOWN 9, OHIO

compact, efficient
LINTERN AIRE-RECTIFIER
requires but little space

1.

THIS IS THE CAB (6' x 6'), in a large modern plant, which has been air conditioned with a Lintern Aire-Rectifier. The operator does his work with ease and accuracy in temperatures of 70°-80° — even on the hottest days when working over the hottest spots.

2.



THIS IS THE CONDENSER UNIT located on cantilever beams over door of the cab — out of the way, and offering no interference with operations. (Can be located wherever desired). It is connected by means of refrigerant lines to the Cab Unit.

3.

THIS IS THE CAB UNIT. It takes only 3 square feet of space and fits easily at the rear of the cab. The operator has plenty of room. It contains the cooling (evaporator) coil, electric heater for winter use, screen type and activated carbon filters. It also includes automatic thermostats and switch for operating the equipment.

The Lintern Aire-Rectifier is a marvel of compactness and efficiency. May we send you the complete story?

THE LINTERN CORPORATION

Salvage has been named advertising manager succeeding Mr. Reeves.

Orval M. Riggs was appointed manager, application engineering for Hays Corp., Michigan City, Ind. Mr. Riggs was chief project engineer in the sales department until his present appointment.

Grant A. Colton was named president of Golden-Anderson Valve Specialty Co., Pittsburgh, Pa. Mr. Colton was formerly vice president and general manager.

Robert J. Anderson, Edward E. Cazel and **George R. Goetz** have been appointed sales-and-service engineers for Brooks Chemicals, Inc., Cleveland, Ohio.

CORRECTION!

In the March 1951 issue of the IRON AND STEEL ENGINEER an item appeared in this section listing the wrong firm name for Mr. E. D. Youmans. The item should have read: "**E. D. Youmans** was named vice president in charge of manufacturing and research for Okonite Co., Passaic, N. J."

Obituaries

Charles Lukens Huston, 94, pioneer steelmaker and first vice president of the Lukens Steel Co., Conshohocken, Pa., died March 14. Mr. Huston marked his 75th anniversary working for the company last July 8. He was active in operations of the firm until his death.

Victor R. Browning died February 15. Mr. Browning was president of Victor R. Browning & Co., Inc., Willoughby, Ohio.

J. A. Voland, president of Golden-Anderson Valve Specialty Co., Pittsburgh, Pa., died March 10.

David C. Ball, 93, organizer and chairman of the board of Oakite Products Corp., New York, N. Y. died March 23. Mr. Ball was active in the work of the corporation until his death.

Corrosion Proof Construction Materials

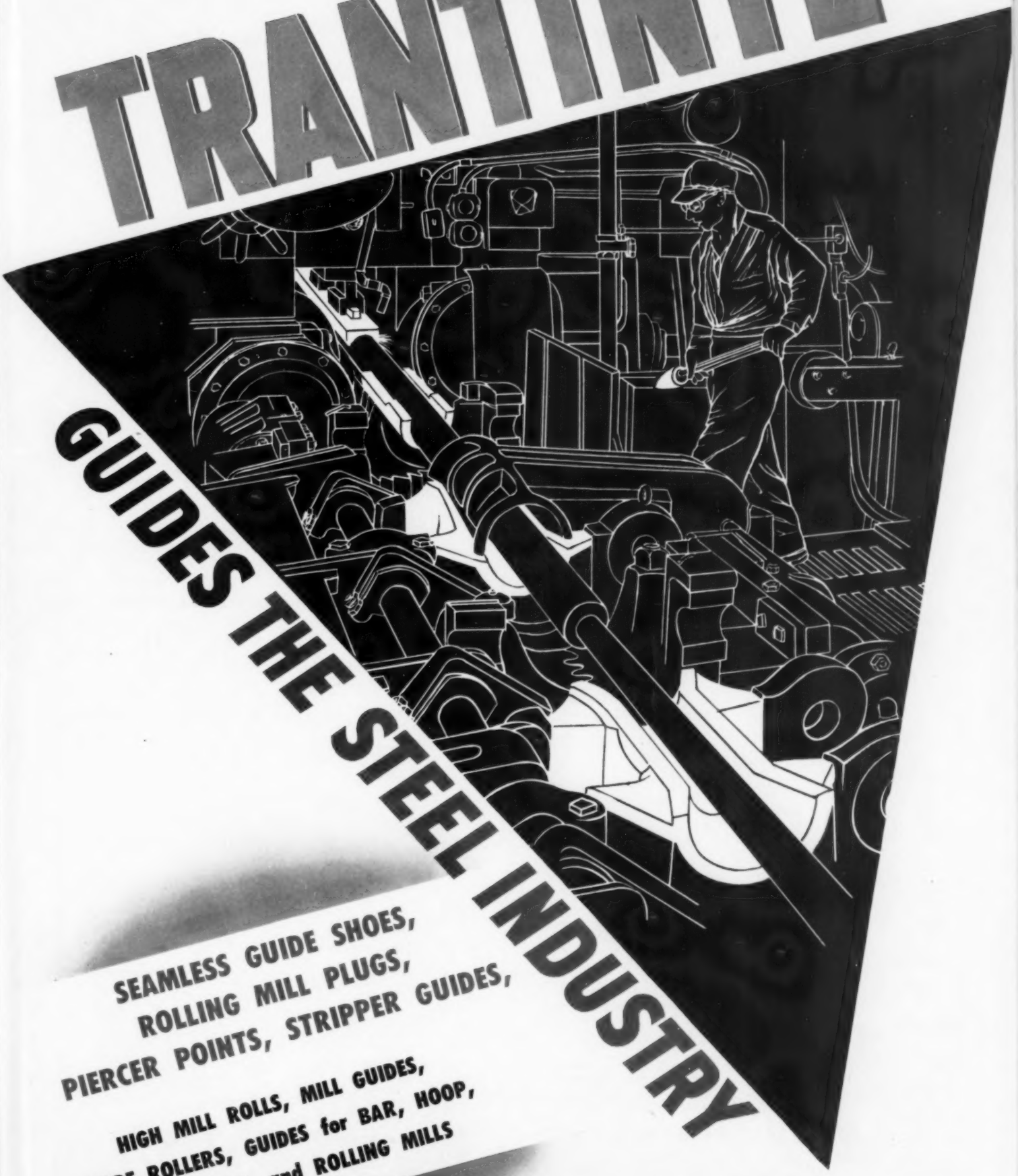
CEMENTS FLOORS LININGS COATINGS

Rely on Atlas' years of experience and recognized leadership to help solve your problems. Write 65 Walnut Street, Mertztown, Pa.

Over a half century of service

Atlas
MINERAL PRODUCTS COMPANY
MERTZTOWN, PA. HOUSTON, TEXAS

TRANTINYL



GUIDES THE STEEL INDUSTRY

SEAMLESS GUIDE SHOES,
ROLLING MILL PLUGS,
PIERCER POINTS, STRIPPER GUIDES,

HIGH MILL ROLLS, MILL GUIDES,
GUIDE ROLLERS, GUIDES for BAR, HOOP,
STRIP, SHAPE, and ROLLING MILLS

Youngstown Alloy Casting Corp.
Youngstown, Ohio

Arthur R. Schulze, 67, former chief engineer of U. S. Steel Co. in the Youngstown, Ohio, district, died March 21. Mr. Schulze went to Youngstown from Pittsburgh in 1931. He designed and constructed the

ARTHUR R. SCHULZE

strip mill of the McDonald works of the U. S. Steel Co.

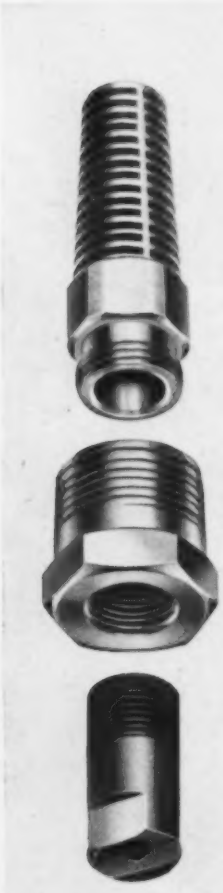
In 1944, he was sent to Johnstown, Pa., as assistant to the superintendent of the Johnstown district. He retired five years later. He worked 44 years with the company, starting at Clairton, Pa., as an engineer.

Harold O. Shepard, for many years sales engineer with United Engineering and Foundry Co., Pittsburgh, Pa., died March 16.

John W. Humphrey, 53, general superintendent of

JOHN W. HUMPHREY

U. S. Steel Co.'s Youngstown, Ohio, district, died March 17. Mr. Humphrey began working for the steel company, then the Carnegie Steel Co., in 1912. He was employed in plants at Dravosburg and Vandergrift, Pa., before he was made assistant superintendent in 1944. He became general superintendent of the Youngstown, Ohio, district in July, 1949.



UNIFORM
descaling
with the
Spraying Systems
Descaling Nozzle

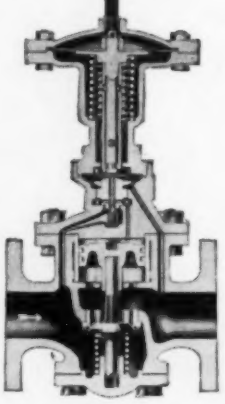
This hardened stainless steel nozzle provides a constantly uniform flat spray for clean descaling operations . . . all streaking is eliminated. Available in wide range of capacities.

LARGE DIAMETER ORIFICE

Note that the orifice is almost circular in shape . . . far less tendency to clog than the "old style" slotted orifice. Initial cost is lower. Maintenance cost is lower.

Write for complete information on this quality built nozzle and its large capacity strainer and adapter. Ask for Catalog 22 and Data Sheet 3997.

SPRAYING SYSTEMS CO.
3262 RANDOLPH STREET
BELLWOOD, ILLINOIS
(Suburb of Chicago)



CLASS LT-3
REDUCING VALVE

TRADE LESLIE MARK
FOR FURNACE
REVERSAL SYSTEMS

CLASS LT-3
REMOTELY ADJUSTED
REDUCING VALVE
with
AIR LOADING PANEL

An ideal combination for control of atomizing steam from a central panel. Easily tied in with fuel valves on O. H. furnace reversal systems.

Write for Bulletin 461A

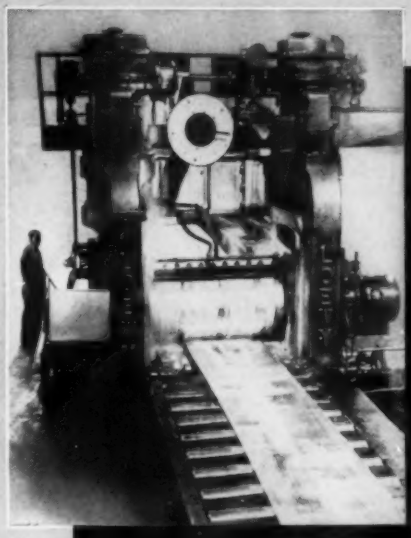
TYPE ARP
Air Loading Panel

LESLIE CO.
247 GRANT AVENUE
LYNDHURST, NEW JERSEY

ESTABLISHED 1900 LESLIE CO.

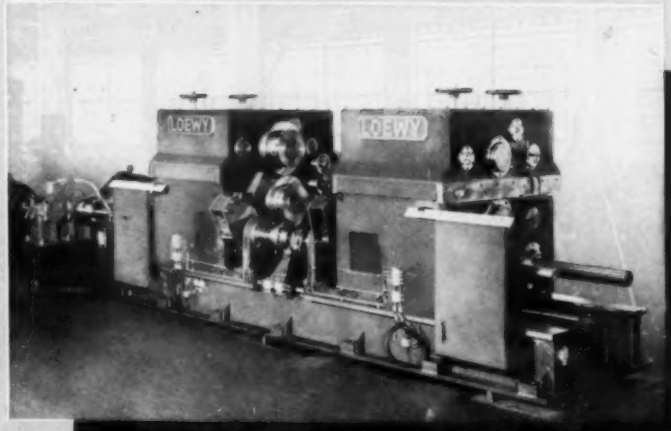
PRESSURE REDUCING VALVES • PRESSURE CONTROLLERS
FLOATLESS LEVEL CONTROLS • PUMP GOVERNORS
TEMPERATURE REGULATORS • SELF CLEANING STRAINERS
AIR HORNS • STEAM WHISTLES

HOT AND COLD ROLLING MILLS
AND AUXILIARY EQUIPMENT
FOR THE STEEL INDUSTRIES



2-HIGH HOT ROLLING MILL

1150 TON UP-CUT BLOOM AND SLAB SHEAR



ROTARY SIDE TRIMMING SHEAR WITH ADJUSTABLE KNIVES AND SCRAP CUTTER

14,000 TON HYDRAULIC FORGING PRESS

LOEWY ROLLING MILL DIVISION
HYDROPRESS · INC ·
ROLLING MILLS AND ROLLING MILL EQUIPMENT

566-568 LEXINGTON AVE. GENERAL ELECTRIC BUILDING AT 51st STREET NEW YORK 22

CHICAGO DETROIT SAN FRANCISCO SEATTLE WASHINGTON, D. C.

This Tap Changer Story began 20 YEARS ago . . .

Straight Line FACTS

Purchasers of transformers are extremely interested in tap changer design because the failure of a tap changer can cause the failure of a transformer.

Twenty years ago Pennsylvaina Transformer Company developed the Straight-Line Tap Changer and began using it in all Power Transformers. Succeeding years brought modifications and improvements but, in essence, the present Straight-Line Tap Changer is the same as the one introduced in 1930.

For twenty years the Straight-Line Tap Changer has functioned in all types of Power Transformers under all operating conditions.

Not once in all this time has there been any reason to question the fundamental principles of the Straight-Line design.

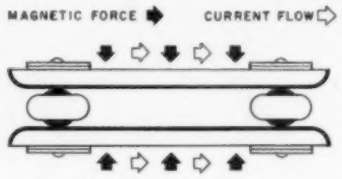
The performance record of the Straight-Line Tap Changer is adding to the reputation of Pennsylvania Transformers. It is one of the reasons for the confidence put in Pennsylvania by a growing number of leading Utilities that are placing important orders for Pennsylvania Transformers.

1. Flexible steel spring construction and straight line motion of movable jaw assures a self-aligning, high pressure contact at all times.

2. All contacts made of a time-tested silver-nickel mixture which possesses the electrical qualities of silver but is inert to chemical reactions. Contacts are pressure and temperature treated for high conductivity and high resistance to wear.

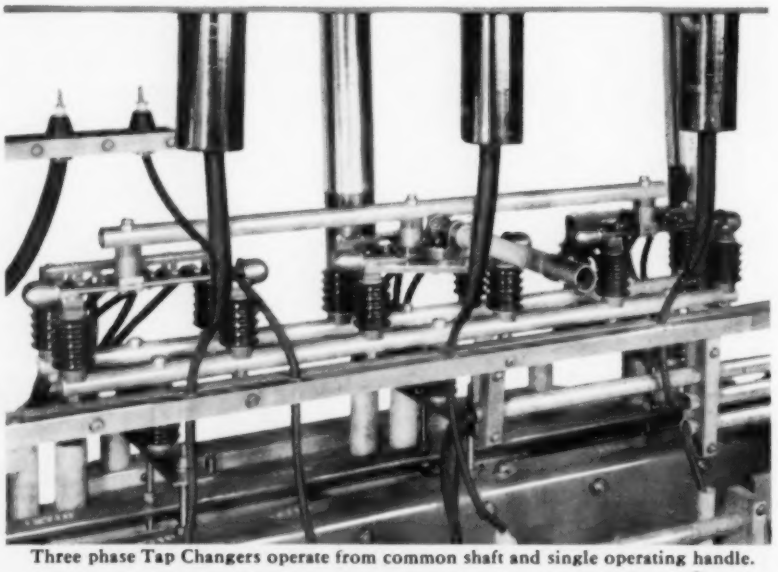
3. Contacts are self-cleaning. Each operation of tap changer results in a positive wiping action.

4. Straight Line Tap Changer withstands dead short circuits. Design of Tap Changer is such that magnetic forces cause moving contacts to increase pressure during short circuits. There is no blow-off action.



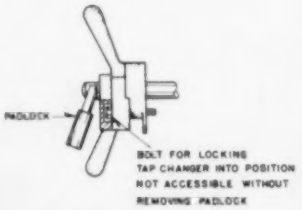
5. Transformer cable leads crimped to ends of stationary jaws. Crimping provides a high quality mechanical and electrical connection without possibility of crystallization due to brazing.

6. Tap Changer located in top section of tank — above core and coils — where it is accessible through handholes or manholes for simplified inspection and maintenance.



Three phase Tap Changers operate from common shaft and single operating handle.

Operating handle issues through side of case and is provided with a positive locking mechanism.



Pennsylvania TRANSFORMER COMPANY

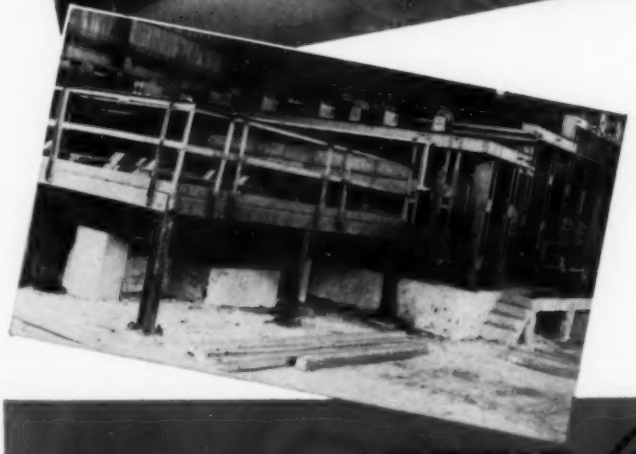
CANONSBURG, PENNA. • Greater Pittsburgh District

It's
LOFTUS
All along the Line

"Wherever Heat is used in Industry"

COMPLETE PLANTS

- **Open Hearths**
- **Soaking Pits**
- **Individual Furnaces**



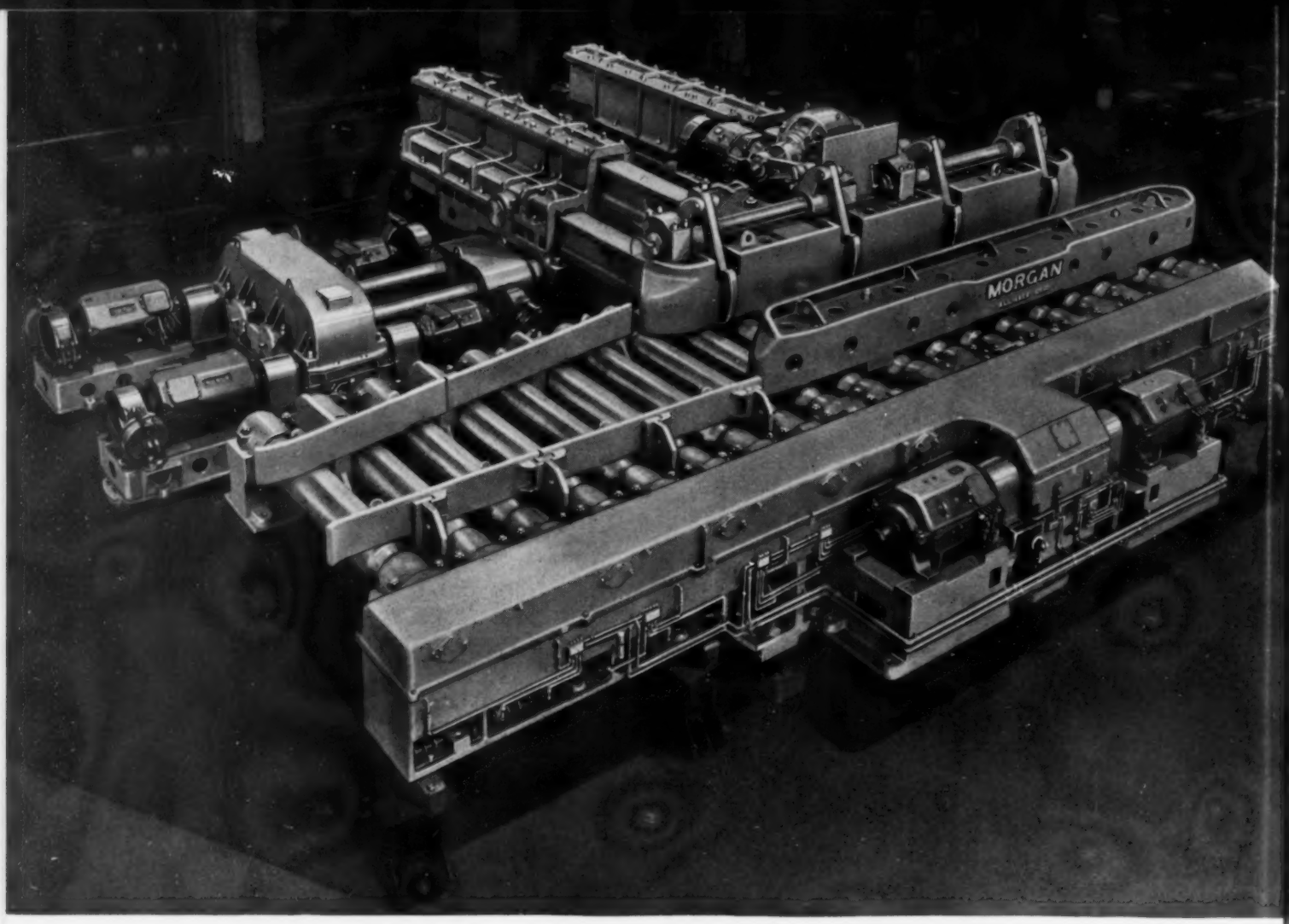
Whether it is the designing and construction of a Complete Plant, a line of Open Hearths, Soaking Pits, or Individual Furnaces, the Loftus organization one of the largest in the country with *specialists* in all phases of industrial heating, is equipped to handle any commitment with skill and exactness — and with undivided responsibility.

LOFTUS ENGINEERING *Corporation*

610 SMITHFIELD ST. PITTSBURGH, PA.

Designers and Builders

Engineers, Consultants, Contractors



45″ BLOOMING MILL TABLE AND MANIPULATOR

Morgan 45″ Blooming Mill Manipulator with Front Mill Table. Manipulator is of the overhead type, electrically driven, with retractable heads so the table rollers can be removed without dismantling the manipulator heads. Table girders are of cast steel box section type with integral oil trough on drive side. All gears are totally enclosed, operating in oil, and have hardened teeth. All bearings are of the anti-friction type lubricated through a centralized motor operated system.

BUILT BY MORGAN Engineering

THE MORGAN ENGINEERING CO.

ALLIANCE, OHIO PITTSBURGH—1420 OLIVER BUILDING

DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE MI
STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIPPI
MACHINES • SOAKING PIT CRANES • ELECTRIC WELDED FABRICATION • LADLE CRANES • STEA
HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL MILL

Equipment News...

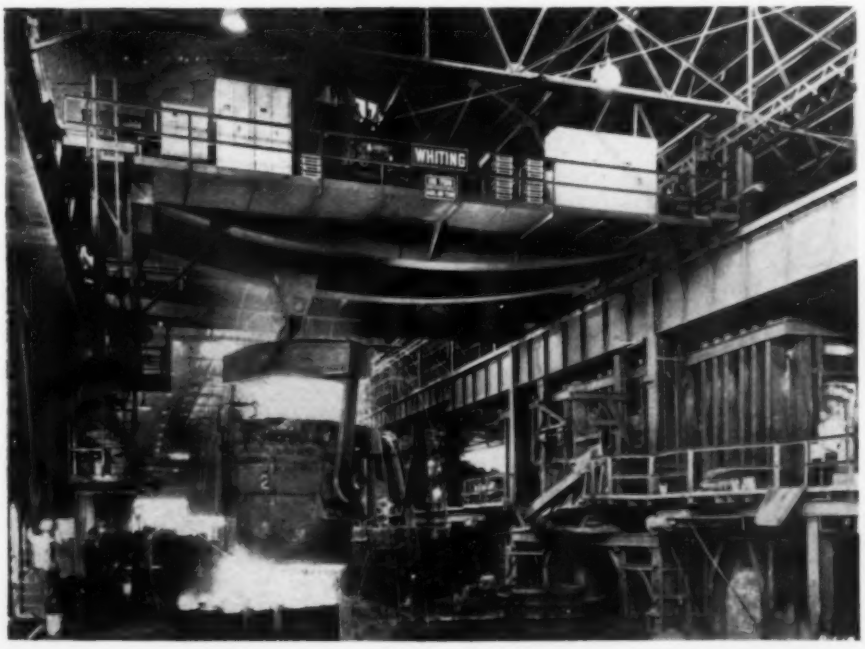
ELECTRONIC DEVICE READS AND RECORDS AT SPEEDS UP TO 50,000 READINGS PER SECOND

▲ A new electronic device to read test instruments at speeds up to 50,000 readings per second and record the readings on tape or punched cards ready for computation was described recently by Dr. G. W. King of Arthur D. Little, Inc., well known research and engineering consultants of Cambridge, Mass. Dr. King, speaking at the Association for Computing Machinery meeting at Wayne University, Detroit, Mich., said that the device was initially developed and constructed by Arthur D. Little, Inc. for its own use.

Called the "Digital Reader," this new instrument is expected to eliminate cumbersome human work involved in recording and computing from strain, pressure, acceleration and temperature gages, pilot plant and other physical and control instruments used in research work in a number of industrial fields. At present it is often necessary to photograph instrument dials at stated intervals; research workers must then laboriously jot down the readings in numerical form and arrange them for computation. Some recording instruments trace out a chart which must be similarly carefully examined and translated in numerical form. The Digital Reader, when linked to the instruments to be recorded, rapidly converts the electrical signals it receives from the instruments directly to convenient binary-digital form for immediate analysis, computation, smoothing or storage on recording media.

Arthur D. Little, Inc. built its first "Digital Reader" to obtain and usefully convert data on infrared spectra. The potential application of the "Digital Reader" in many engineering fields was immediately recognized. The original models proved so valuable that Arthur D. Little, Inc. is now building a number of units as part of a special consulting service in the data-handling field. It is a unit about 20 in. x 30 in. x 5 in., operating from 110-125 volts, and easily incorporated in a variety of multiple-instrument reading and recording systems.

CRANE USES D-C MAGNETIC CONTROL



This 115-ton Whiting Corp. crane, recently installed in the South San Francisco, Calif. plant of Bethlehem Pacific Coast Steel Corp., is equipped with General Electric motors and controls. The crane, utilizing five motors with a total rating of 180½-hp, features a new d-c magnetic control. Better control and ease of handling have reduced the time required to pour each "heat" of molten steel. The new crane also accommodates a larger ladle, which in turn permits heavier heats to be tapped from the furnaces.

HYDRAULIC DUPLICATOR

▲ The hydraulic duplicating attachment follower illustrated, manufactured by Turchan Follower Machine Co., is built to suit any combination of feeds, speeds, and tooling that can be used on a lathe. Shown is the contour duplicating of an 11½ in. diameter shaped roll of chilled iron, completed in only six hours, compared to thirty-four hours with the method formerly used.

In another case, a 4½-in. step shaft was turned on a 16-in. lathe similarly equipped. The depth of the cut was ½-in.; the speed 255 fpm; and the feed .018 in. A Turchan attachment reduced time spent on this job from forty-eight to fourteen minutes.

The important functional feature of this duplicating attachment is that the tool-slide operates at a 45-degree angle to the work axis. This movement, combined with the longitudinal movement of the lathe carriage, permits the reproduction of perfectly square shoulders, as well as radii and bevels, in exact accordance with any square shoulders, radii, and bevels encountered by the tracer as it traverses the template.

An unusually high quality surface finish is attained because the cut is not interrupted, and this method of duplication also affords the elimination of special form tools for turning intricate shapes.

Trial cuts are made with the finishing tool on the first work diameter until a micrometer shows the finished size. The machine is then automatically set to reproduce all diameters

from the round model or flat template, so that subsequent measuring is eliminated.

Another important characteristic of Turchan equipment is its ability to reproduce work accurately to within .002 of an inch.

The conventional cross-slide is replaced by one equipped with two compound rests, mounted at 45 degrees to the lathe center line and 90 degrees to each other. Cross and longitudinal travels are actuated by the conventional lead-screws, while 45 degree compound movements are controlled by the tracer. This new combination of movements doubles the function of tools on any standard lathe.

Parts with contours on the diameter or face can be duplicated, as well as a combination of both. The lathe is operated in the conventional manner, none of its standard controls being removed. To change from one angular slide to the other, a single change-over lever is provided, which also indicates the direction of duplicating. Only one slide is used at a time; the other remaining in locked position. Thus square, right, and left-hand shoulders, including under-cuts and radii, can be machined.

An 11½ in. diameter roll was contour duplicated in only six hours.

ELECTRIC SCRAP BALER

▲ By replacing manually operated levers with electrically controlled compressed air cylinders, Riverside Metal Co. now operates its "cabbage" machines with one man instead of the two formerly required. The change-over will pay for itself in less than ten months.

The illustration shows how the scrap-metal balers were converted to effect this saving. Formerly, to operate the hydraulic rams which compress scrap metal into easily handled bales, the dotted-in levers had to be manipulated manually. This required one man at the loading zone and a second at the levers.

Replacement of the three levers with remote-controlled cylinders (arrow) permits one man, from one side of the machine, to load, operate and unload the baler. The result is more than twice as many bales per man-hour, plus liberation of man-hours for use elsewhere in the plant. Current defense activities of the copper

Electrically controlled compressed air cylinders replaced manually operated levers on this scrap baler.

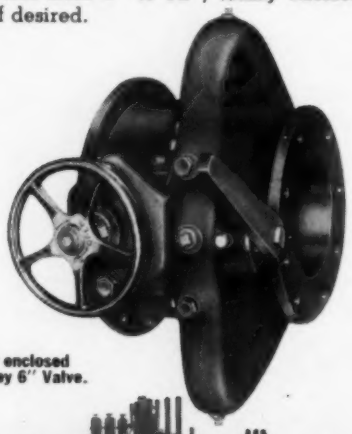
Dependable Operation under all conditions!

60" x 48" Bailey Valve for Horizontal Gas Main.

Bailey MECHANICAL GOGGLE VALVES

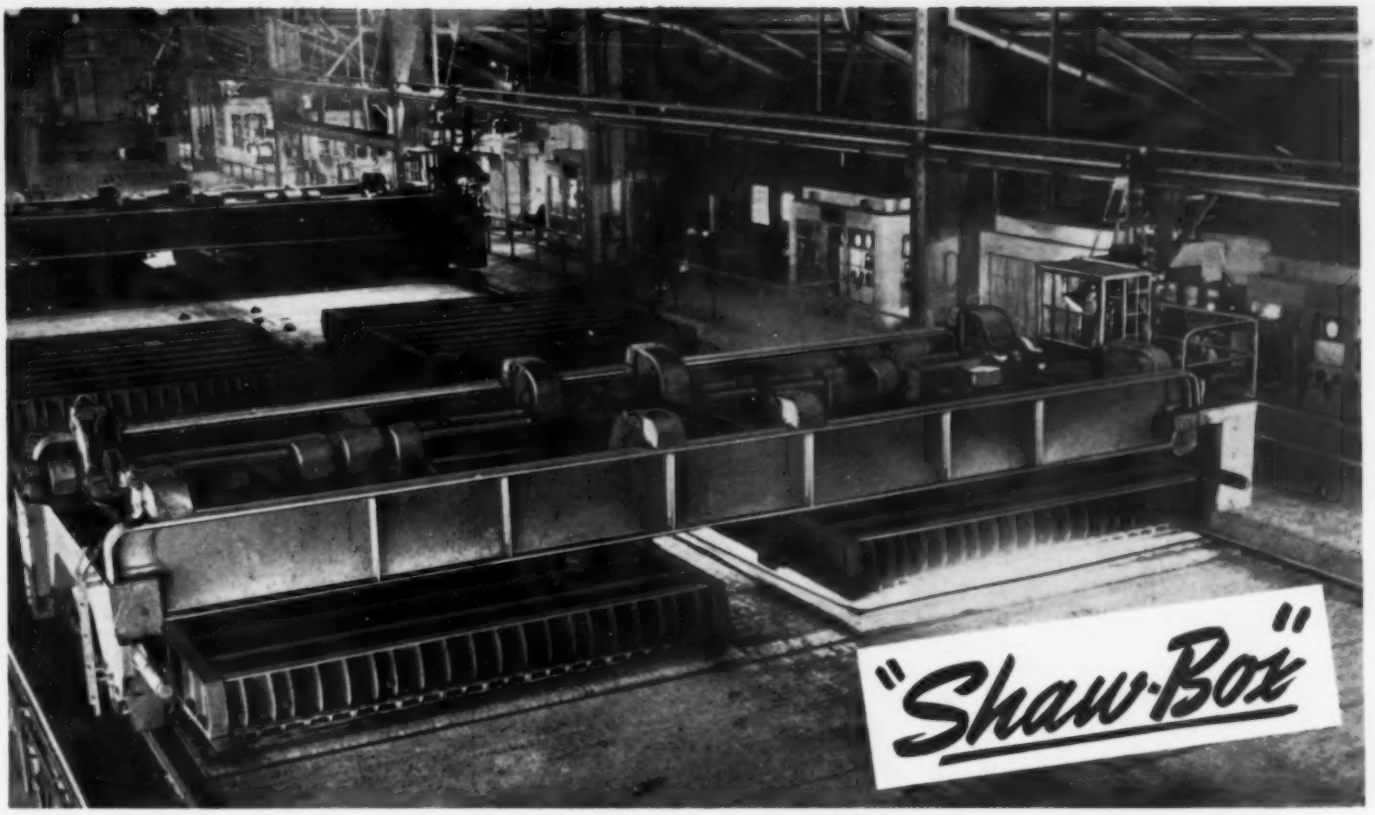
BAILEY Goggle Valves provide a tight, positive seal for shutting off gas mains in emergencies or for repairs. Requiring a minimum of maintenance, they operate by a powerful clamping force which is applied equally at all points around the disc periphery. Regardless of time between operations, they open or close instantly. Sizes from 6" to 72", totally enclosed if desired.

Instant Service Where It's Wanted, for—
GAS WASHERS
GAS MAINS
COKE PLANTS
BOILER PLANTS



Totally enclosed type Bailey 6" Valve.

WILLIAM M. Bailey COMPANY
ENGINEERS
LEADERSHIP THROUGH QUALITY
1221 BANKSVILLE ROAD PITTSBURGH 16, PA.



SOAKING PIT CARRIAGES

When your Soaking Pit Carriages are "Shaw-Box," they give dependable, economical, trouble-free service under the most severe operating conditions. Exclusive patented features, found only in "Shaw-Box" construction, assure smoother operation, reduced impacts on the carriage, pits and pit covers, and lowest maintenance costs.

These important advantages result from lifting with eccentrics instead of the ordinary crank mechanism or hydraulic cylinder; spherical bearings on top and bottom of hangers that permit lifting beams to "thread" into lifting tees; traverse motor and cross-shaft mounted inside girder to give the utmost protection; and a system of interlocks that provide maximum safety.

Designing and producing Soaking Pit Carriages has long been a "Shaw-Box" specialty. Simple, rugged, and extremely accessible, they are built to give real service with a minimum of attention. Exacting "Shaw-Box" standards of fine workmanship, engineering, and precision manufacturing methods insure a performance that makes them — for the work they do — the least expensive to buy and use.

Be sure to send all your inquiries for Steel Mill Cranes and Soaking Pit Carriages to "Shaw-Box."

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

MANNING, MAXWELL & MOORE, INC.

SHAW-BOX CRANE & HOIST DIVISION

MUSKEGON, MICHIGAN

Builders of "Shaw-Box" Cranes, 'Budgit' and 'Load-Lifter' Hoists and other lifting specialties. Makers of 'Ashcroft' Gauges, 'Hancock' Valves, 'Consolidated' Safety and Relief Valves, 'American' Industrial and 'Microsen' Electrical Instruments.

Quick-As-Wink
AIR AND HYDRAULIC
Control Valves

Valve Closed to Live Air— Open to Exhaust

Valve Open to Live Air— Coupling Locked

VALVE COUPLINGS ¼", ⅜", ½", & ¾" SIZES

For Economy and Safety

● These couplings permit air to be shut off and tools changed quickly without going to the main shut-off valve. Coupling jaws are automatically self-locking when valve is open to air supply. The coupling cannot be disconnected until the valve sleeve is moved to closed and exhaust position,— thus preventing accidents and injuries. Pressures to 250 p.s.i.—hose shank, male or female pipe connections. *Send for Bulletin No. 104-C. It gives full details and prices.*

THE HIGHER THE PRESSURE THE TIGHTER THE SEAL

Quick-As-Wink
AIR AND HYDRAULIC
Control Valves

Hand, Foot, Cam, Pilot, Diaphragm and Solenoid Operated

Mfd. by C. B. HUNT & SON, INC., 1986 East Pershing St., Salem, Ohio

alloys producer make this additional man-power sorely needed.

This idea, though applied here to "cabbage" machines, is readily adapted to other manually operated equipment.

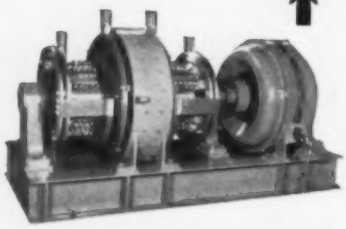
SYNTHETIC WAX

▲ The problem of protecting electrical components such as coils from moisture to prevent shorting out has always been a serious one. Common practice has been to impregnate the coil with varnish by a pressure-vacuum method and then, in many cases overcoating with microcrystalline waxes. This method has only been moderately satisfactory in applications where water, particularly when detergents may be present, can easily come into contact with the unit.

The development of a new synthetic wax, by Glyco Products Co., Inc., Wax S-1167, overcomes this difficulty by giving a very effective moisture barrier. Coils impregnated with this wax by a pressure-vacuum system have resisted shorting for a minimum of 30 cycles after being steeped in water containing a powerful detergent before every cycle. The

COLUMBIA

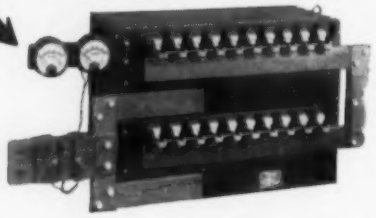
MOTOR GENERATORS



for

Electroplating
Anodizing
Electrocleaning
Electropolishing

TANK RHEOSTATS

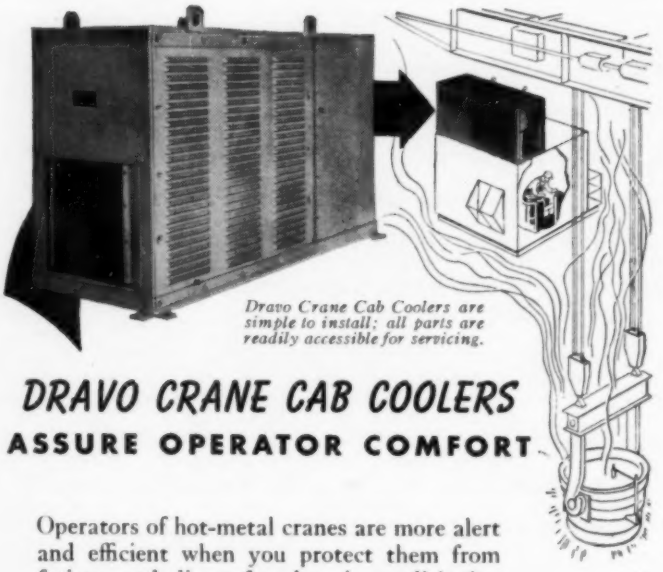


• TONG TEST AMMETERS

• REVERSING SWITCHES

Write for Descriptive Bulletins

COLUMBIA ELECTRIC MFG. CO.
4543 HAMILTON AVE. CLEVELAND 14, OHIO



Dravo Crane Cab Coolers are simple to install; all parts are readily accessible for servicing.

DRAVO CRANE CAB COOLERS
ASSURE OPERATOR COMFORT

Operators of hot-metal cranes are more alert and efficient when you protect them from fatigue and discomfort by air conditioning the cabs with Dravo Crane Cab Coolers.

Completely self-contained, and requiring only an electrical connection, the Dravo Crane Cab Cooler provides complete air conditioning:

Cooling	Continuous Ventilation
Fume and Odor Removal	Dehumidifying
Dust Filtering	Winter Heating

DRAVO CORPORATION
PITTSBURGH • PHILADELPHIA • CLEVELAND • NEW YORK
CHICAGO • DETROIT • ATLANTA • BOSTON
Sales Representatives in Principal Cities

DRAVO

old type impregnated and overcoated coils fail in such a test in a maximum of 6 to 7 cycles.

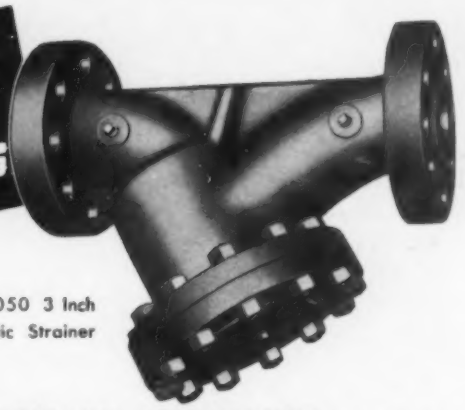
The wax is a completely synthetic dark organic wax with a ball and ring melting point of 120-125 C and a flash point higher than 250 C. It is very tough and non-brittle and does not tend to become very brittle at low temperatures. This material has good electrical properties and resistance to water and oils. When applied to metals as a hot melt it has good adhesion to the surface of the metal, with a minimum of shrinkage. It is also indicated to be of interest for use as a waterproofing and laminant for paper, textiles, wood, etc., where its dark color is unimportant.

HEATING APPARATUS

▲ Patent No. 2,545,725, Metallurgical Heating Apparatus, was recently issued to Harry Dobrin, president, Furnace Engineers, Inc.

This invention relates to heating apparatus for melting or treating metal, and more particularly, to apparatus including means for exhausting combustion gases from the heating chambers. Included among the equipment with which this heating

Quick-As-Wink
AIR AND HYDRAULIC
Control Valves



No. 16050 3 Inch
Hydraulic Strainer

HIGH PRESSURE HYDRAULIC STRAINER to 1500 p.s.i.

protects valves, cylinders and spray nozzles

● Electric furnace cast steel housing. The strainer consists of machined and grooved bronze rings nested around a heavy slotted multi-ported bronze back-up cylinder. The rings can be loosened and cleaned easily with compressed air, or completely removed and cleaned in solvent. Repay their cost many times over. Widely used in steel mills and forging shops to prevent partial plugging of spray nozzles, resulting in rejects due to scale streaks. 1½" to 6" sizes. Send for Data Sheet No. 3402. It gives full details.

THE HIGHER THE PRESSURE THE TIGHTER THE SEAL

Quick-As-Wink
AIR AND HYDRAULIC
Control Valves

Hand, Foot, Cam, Pilot, Diaphragm and Solenoid Operated

Mfd. by C. B. HUNT & SON, INC., 1985 East Pershing St., Salem, Ohio

Adalet "Sali" Cable Seals

Easy

to install. Effective and compact. For lead sheath or braid cable.

Protects against moisture, oils, abrasives.
All-insulated cover and body above lead sheath.
Diameter permits close nesting of conduits.
One or more cables can be sealed off in one body.
Holes drilled to fit cable diameter as specified.
All types — upright, horizontal, inverted.
Voltage, 600 to 5000.
No lead joints to wipe.

THE ADALET MANUFACTURING CO.
14300 LORAIN AVE.
CLEVELAND 11, OHIO

write for Cable Seal Supplement

CRANE BUILDERS Since 1903

BEDFORD CRANES

Capacities 5 to 150 Tons

Designed and Engineered to Meet Your Requirements

Any Span or Lift
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GANTRY CRANES • STEEL DERRICKS
BUILT TO YOUR SPECIFICATIONS
STRUCTURAL STEEL • STEEL BUILDINGS

BEDFORD FOUNDRY & MACHINE CO.

Engineers
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U. S. A.

Gray
Iron
Castings

apparatus may be used are galvanizing settings, wherein the combustion gases from the burners which heat the galvanizing pots may be drawn out of the heating chambers by eductors that are operated by air pressure.

It is among the objects of this invention to provide heating apparatus of the eductor type in which provision is made for delivering air to the eductor to operate it during low burning periods in case the temperature that is being controlled starts to rise above a predetermined maximum.

The products of combustion are let off at the center of the furnace through a flue to a short stack upon which will be mounted a transition piece and FEI eductor unit. Air is admitted at two points of the venturi: one point aiding the flow of the products of combustion up the stack, and the other, creating a back pressure to hold the products of combustion in the furnace setting. On the amount of fuel entering the burners depends the admission of air to the venturi. As more fuel is burned in the setting, then air aids the educting of the flue gases. At very low flows, back pressure air will hold the products of combustion in the setting. The adjustable port valves are set in such a manner that a constant pressure condition is maintained in the setting itself independent of the amount of fuel being burned.

A temperature limiting control unit automatically exhausts the products of combustion from the setting when the temperature of the furnace goes beyond a predetermined control position.

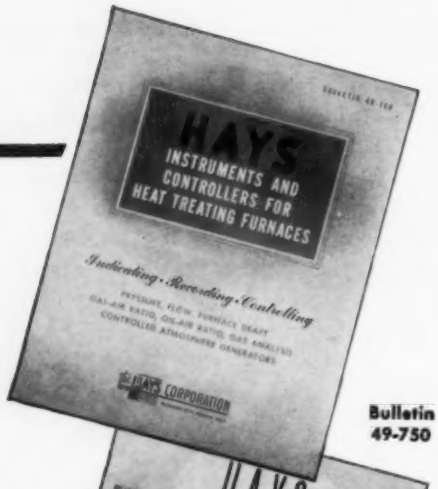
This invention is particularly applicable to galvanizing settings.

Bulletins on instruments and control for 2 types of furnaces

HEAT TREATING FURNACES

A complete summary of Hays products applicable to processes such as annealing, brazing and calorizing. Scope includes various methods of firing (underfired, overfired, sidefired), fuel burned (gas, coal, oil), and type of furnace (continuous, rotary hearth, slab heating, etc.).

Hays complete line of draft gages, flow gages, and meters (for high and low pressure gases and liquids), portable gas analyzers and automatic CO_2 recorders are covered.

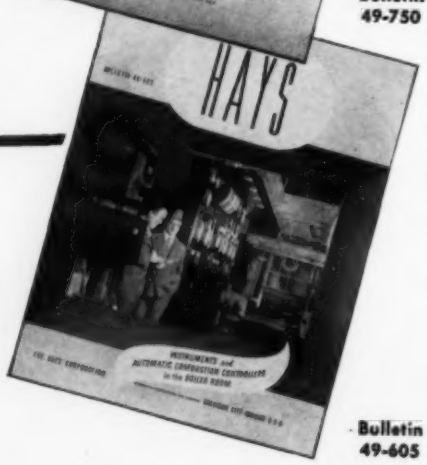


Bulletin 49-750

BOILER FURNACES

This bulletin summarizes applications of Hays centralized combustion control to chain grate, underfeed, spreader type, or lever type stokers; to attritia type, bowl type or ball bearing type pulverizers; to a wide range of oil burners including the rotary cup; and to a wide range of gas burners.

The Hays complete line of draft gages, flow gages, and meters (for high and low pressure gases and liquids), portable gas analyzers, automatic CO_2 recorders, and electronic type O_2 recorders are covered.



Bulletin 49-605

Write for these informative bulletins today.

THE **HAYS** CORPORATION

MICHIGAN CITY 13, INDIANA

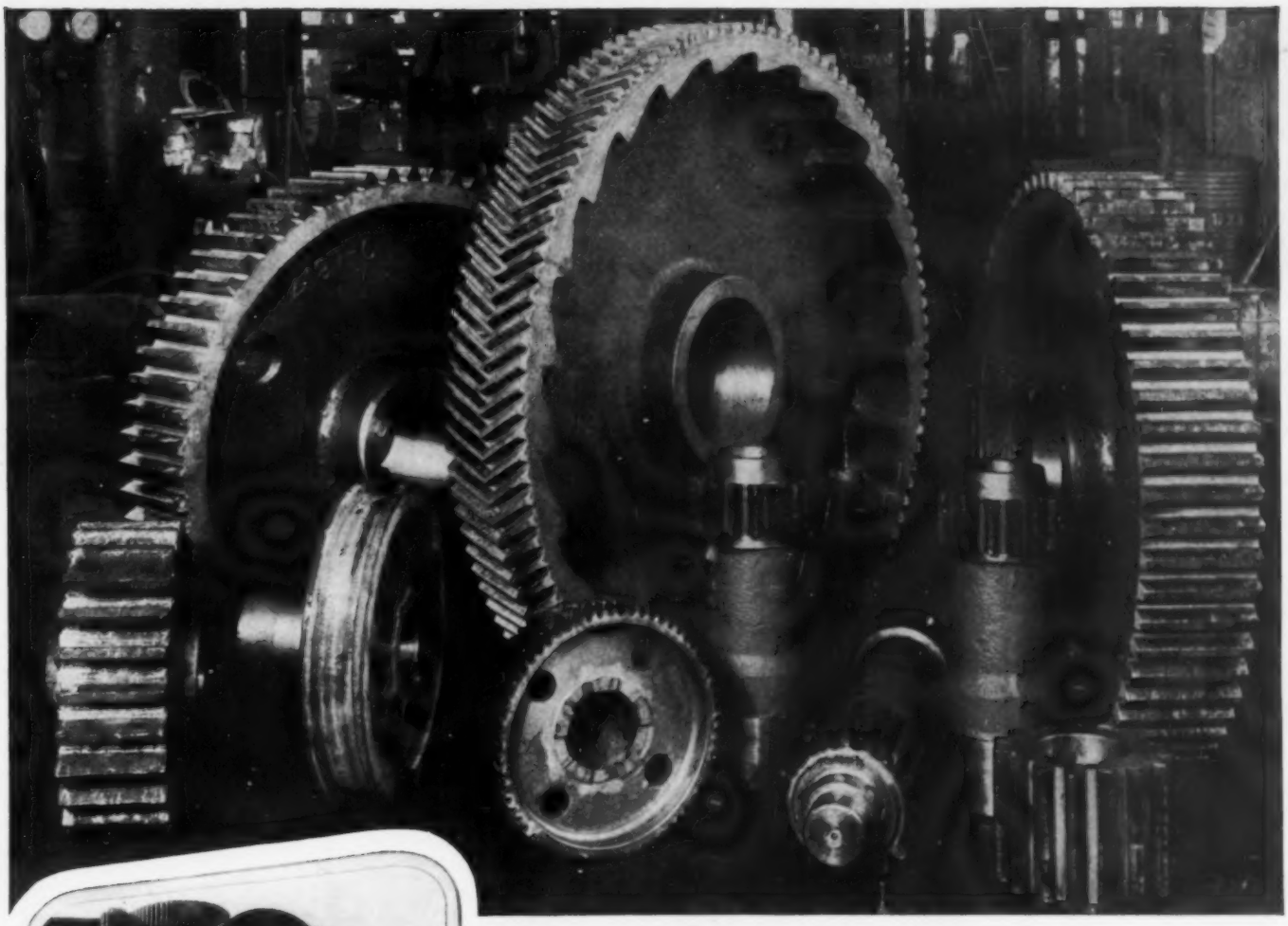
combustion and industrial instruments and control

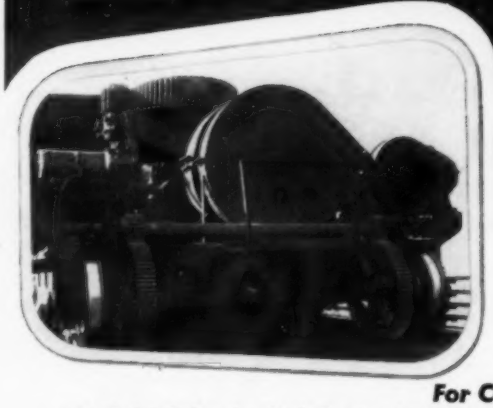
FLAME STRAIGHTENING

▲ Flame-straightening is saving a west coast fabricator approximately $2,000 a year since the method was adopted to straighten about a hundred heat-warped steel boxes each year. The boxes were formerly straightened cold, using a 50-ton jack. Considerable cutting and rewelding were required, and 60 to 100 man-hours were needed for each box. Now the job is done in about 30 hours with flame-straightening.

Two operators, using oxy-acetylene heating blowpipes, manufactured by Linde Air Products Co., heat a triangular patch in the sides of the boxes while force is applied with the 50-ton jack. By this method the sides, 16 ft long, 4 ft high, and topped with 12 in. extra heavy channel, are pulled back into shape. The flame-straightening method also eliminates an undesirable twist caused by exposure to heat. Cold straightening failed to remove this twist.

Flame straightening saves one fabricator approximately $2000 per year.





NE

CRANE GEARS and TRACK WHEELS have Greater Internal Stress Value

HERE IS WHY

For Comparative Purposes

We tabulate below the physical properties of the surface and core values of SAE-1020, SAE-2315, Steels, Carburized or Case Hardened with "Neloy" and "Neloy-Moly" Steels Normalized or Liquid Quenched, Finish Machined and Flame Hardened

S.A.E. 1020 Case-Hardened (Surface)	260/300,000	180/195,000	5–10	8–10	514–601	70–77
S.A.E. 1020 Case-Hardened (Core)	60/ 70,000	30/ 35,000	30–35	40–50	120–140	17–21
Neloy Annealed and Flame-Hardened Treatment 10B (Surface)	218/270,000	190/240,000	8–12	20–35	477–601	66–77
Neloy Annealed and Flame-Hardened Treatment 10B (Core)	85/ 90,000	55/ 65,000	23–40	30–40	163–170	25–26
S.A.E. 1020 Case-Hardened (Surface)	260/300,000	180/195,000	5–10	8–12	514–601	70–77
S.A.E. 1020 Case-Hardened (Core)	60/ 70,000	30/ 35,000	30–35	40–50	120–140	17–21
Neloy Heat Treatments No. 3 and 10B (Surface)	220/270,000	200/240,000	8–12	20–35	555–601	73–77
Neloy Heat Treatments No. 3 and 10B (Core)	100/110,000	80/ 90,000	20–26	40–50	207–241	32–36
S.A.E. 2315 Case-Hardened (Surface)	290/329,000	185/205,000	4– 8	6–10	578–653	75–81
S.A.E. 2315 Case-Hardened (Core)	112/129,000	99/120,000	12–20	38–51	248–277	37–41
Neloy-Molybdenum, Normalized, Drawn and Flame-Hardened (Surface)	258/281,000	212/247,000	6–10	8–12	514–555	70–73
Neloy-Molybdenum, Normalized, Drawn and Flame-Hardened (Core)	90/110,000*	65/ 85,000*	18–25	30–40	187–223	28–33
S.A.E. 2315 Case Hardened (Surface)	290/329,000	186/205,000	4– 8	6–10	578–653	75–81
S.A.E. 2315 Case-Hardened (Core)	112/129,000	99/120,000	12–20	38–51	248–277	37–41
Neloy-Molybdenum Heat Treatments 3A and 10B Flame-Hardened (Surface)	282/318,000	217/265,000	4– 8	6–10	555–627	73–79
Neloy-Molybdenum Heat Treatments 3A and 10B Flame-Hardened (Core)	132/150,000	120/135,000	10–18	25–35	285–321	42–47

*The variation in tensile and yield in the third table is due to the alloyed elements of 2315 which is a nickel steel. This produces a higher physical on a straight annealed steel compared with more economical alloy used in Neloy-Moly.

NATIONAL ERIE CORPORATION

ERIE, PENNSYLVANIA • U. S. A.

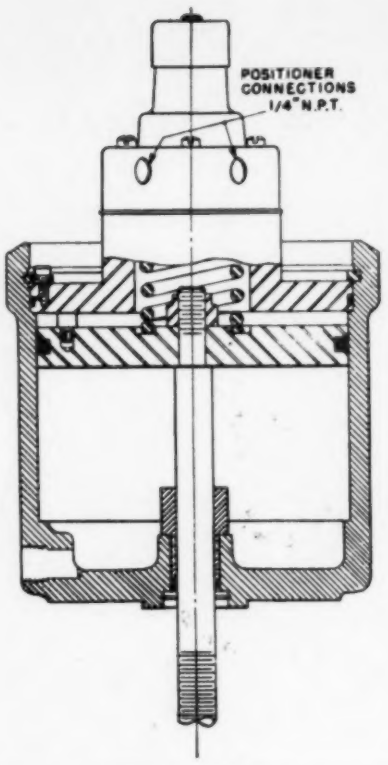
NE

THROTTLING CONTROL

▲ Conoflow Corp. announces the B-50 series of pneumatic cylinders for throttling control service. The cylinders consist essentially of a new design of "O" ring sealed pneumatic cylinder with a piston positioner integrally mounted in the head plate.

In designing these cylinders, many new techniques and new materials were utilized to obtain the sensitivity, accuracy, and the ruggedness demanded by the control equipment industry.

The cylinder itself is a bucket-type cylinder of cast aluminum. The cylinder is accurately machined, honed and polished to provide absolute concentricity of bore and maximum surface smoothness. A one-piece piston is fitted with a graphite-impregnated "O" ring, providing a perfect seal with a minimum of friction. Head plate and piston stem are also "O" ring sealed, eliminating head bolts and gland packing.



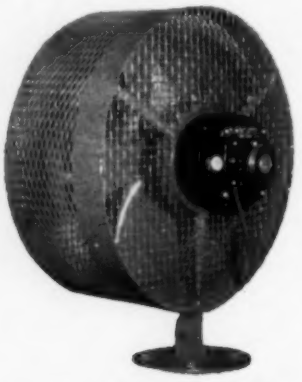
These pneumatic cylinders were designed for throttling service.

The positioner is integrally mounted on the head plate, and takes its position by means of a contact spring riding on the piston. The cylinders are suitable for use with air supply pressures up to 100 psig and are capable of repositioning accuracies to $\frac{1}{500}$th part of the total travel.

AIR RAM ELEVATOR

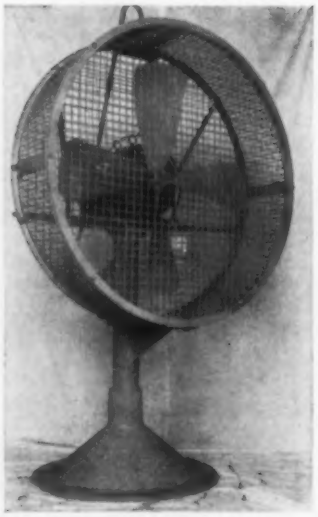
▲ For delivery of heavy lubricants, and mastic-materials which will not readily seek their own level, Lincoln Engineering Co. announces a new hydraulically-operated, single air ram elevator for use with their heavy duty air-motor operated drum pumps. The manufacturer claims the unit will exert 7,110 lb pressure on material and will completely empty and clean sides of 400 lb or 55 gal drums. The unit consists of the air ram with three-position control valve for raising, lowering, or holding pump and follower assembly in desired position. Air regulator with gage controls air pressure required for forcing pump and follower assembly against material. Solenoid valve, actuated by micro-switch attached to control valve on material delivery hose, admits air to the pump permitting operation of pump only when material

IS HEAT SLOWING UP YOUR WORKMEN?



TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 in. sizes.

Keep them COOL with TRUFLO FANS



TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

Production suffers when workmen are overheated. Steps begin to drag, efficiency falls.

Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

PORTABLE COOLING FANS
CRANE CAB FANS • WALL FANS
EXHAUST FANS • BLOWERS
ROOF VENTILATING FANS
PENT HOUSE FANS

TRUFLO FAN COMPANY

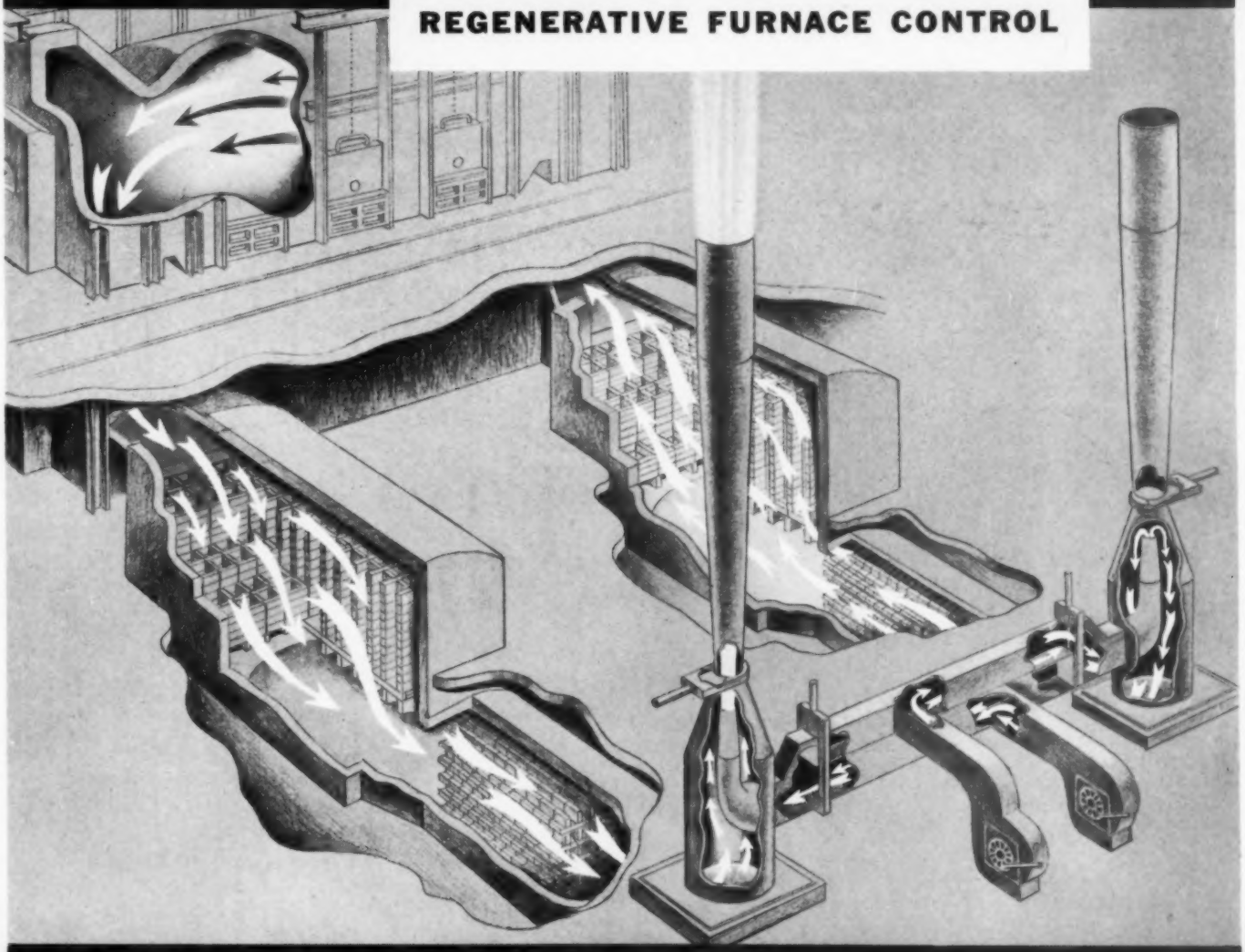
245 MAIN ST., HARMONY, PA.

once again you're asked to INCREASE OUTPUT . . .

The quickest and least expensive way to get more out of your regenerative furnaces is to equip them with Isley Controls. Not only will the Isley speed up your furnaces but will produce better steel. And, because of the extra checker space, and complete control of combustion air, the Isley will make spectacular savings in fuel.

Let us tell you what Isley Controls will do on your furnaces.

MORGAN-ISLEY
REGENERATIVE FURNACE CONTROL

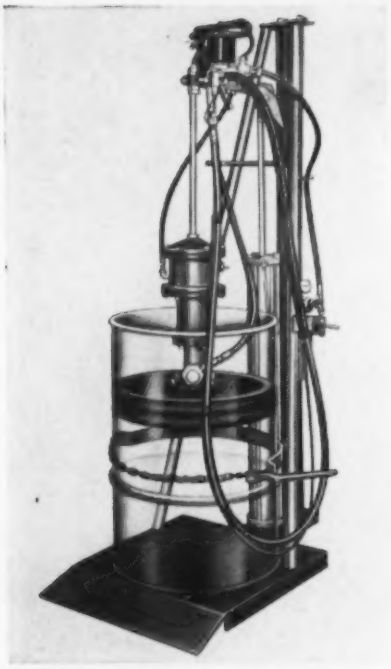


MORGAN CONSTRUCTION COMPANY WORCESTER, MASS.

CCC-27

ROLLING MILLS • MORGOIL BEARINGS • REGENERATIVE FURNACE CONTROLS • AIR EJECTORS • PRODUCER GAS MACHINES

PITTSBURGH, PA., 2815 Koppers Bldg. *English Rep.*, International Construction Co., 56 Kingsway, London W. C. 2, England



The elevator will completely empty a 55 gal drum of heavy lubricant.

is being delivered. Automatic follower vent breaks seal between double-edged sealing member of follower assembly and material when elevator is raised. Built-in chain with toggle clamp holds drum in position on elevator platform.

INSTALL PUMPS AT J & L

▲ Three large pumps with a total capacity for handling 63,000 gpm of water will be installed by the machinery division of Dravo Corp. for the new open hearth furnace plant at Jones & Laughlin Steel Corp.'s Pittsburgh, Pa., works.

The pumps will be housed in a reinforced concrete structure along the shore of the Monongahela River. Construction of this river intake within a sheet steel cofferdam has been started by Dravo.

Each of the three DeLaval pumps will be driven by a 1250 hp electric motor. Water from the river will be screened, strained and treated before being pumped into the mill's piping system.

At J & L's Aliquippa, Pa., works, Dravo will construct a new coal unloading dock extending some 1650 ft along the Ohio River bank.

Included in this project is a 466-ft steel pile wharf with a central reinforced concrete pier for support of coal unloading machinery. Also to be installed are seven sheet steel mooring cylinders 16 ft in diameter and three ice breaker cylinders 25 ft in diameter.

LUMINESCENT TAPE

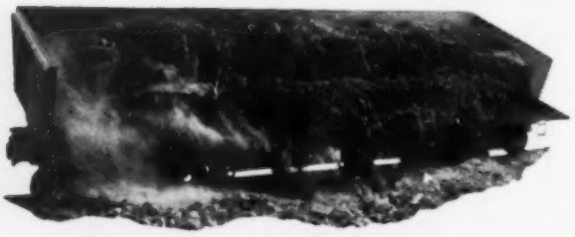
▲ "The Guiding Light" may be appropriately applied to the luminescent packaging tape developed by Century Coating Co.

Ideal for use in blackout areas, the luminescent tape can be seen easily from a distance of several feet. It is used to seal and mark boxes and containers of all sizes and shapes, and can be put on any object that must be readily identified in the dark.

In order to instill toughness, abrasion and chemical resistance, flexibility in hot and cold weather, and to insure a moisture proof coating for the luminescent pigment, it was decided to use a plastisol made from Geon paste resin, a B. F. Goodrich Chemical Co. product, as a coating for the "glowing" tape.

A succession of plastisol coatings or layers are put on fabric in six

GENERATION of SERVICE
RUGGED & DEPENDABLE



MAGOR AIR DUMP CARS

Built for Steel Plant Service, Magor Air Dump Cars will operate at maximum efficiency for as long as 30 years.

Maintenance costs are less — almost 50% less than gondola, hopper or outmoded air dump cars. Every feature of Magor Air Dump Cars is designed to stand up under the tremendous strain of continuous operation.

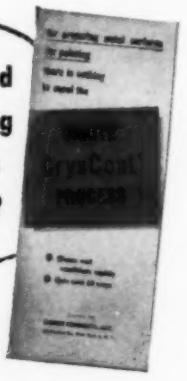
Magor Air Dump Cars can cut your refuse disposal costs as much as 40%.

Write for Bulletin DS-102.

MAGOR CAR CORPORATION, 50 CHURCH ST., NEW YORK, N. Y.
World's Largest Producer of Air Dump Cars

This FREE Folder Tells How To Do It

Can you clean steel and condition it for painting for less than 20 cents per 1,000 square feet?



WITH minimum equipment . . . in minimum time . . . at minimum cost . . . the OAKITE CrysCoat PROCESS* cleans metal surfaces and prepares them for painting . . . prevents corrosion before and after the metal is painted. *Reg. U. S. Pat. Off.

FREE Write to Oakite Products, Inc., 19 Thames St., New York 6, N. Y., for Folder F7642. This 8-page illustrated leaflet describes 19 advantages of the OAKITE CrysCoat PROCESS and lists 10 ways in which it cuts the cost of cleaning and preparing for painting.

ALSO *ask about Oakite procedures for:*

Machine cleaning	Tank cleaning	Electrocleaning
Steam-gun cleaning	Pickling	Paint stripping
Barrel cleaning	Burnishing	Rust prevention

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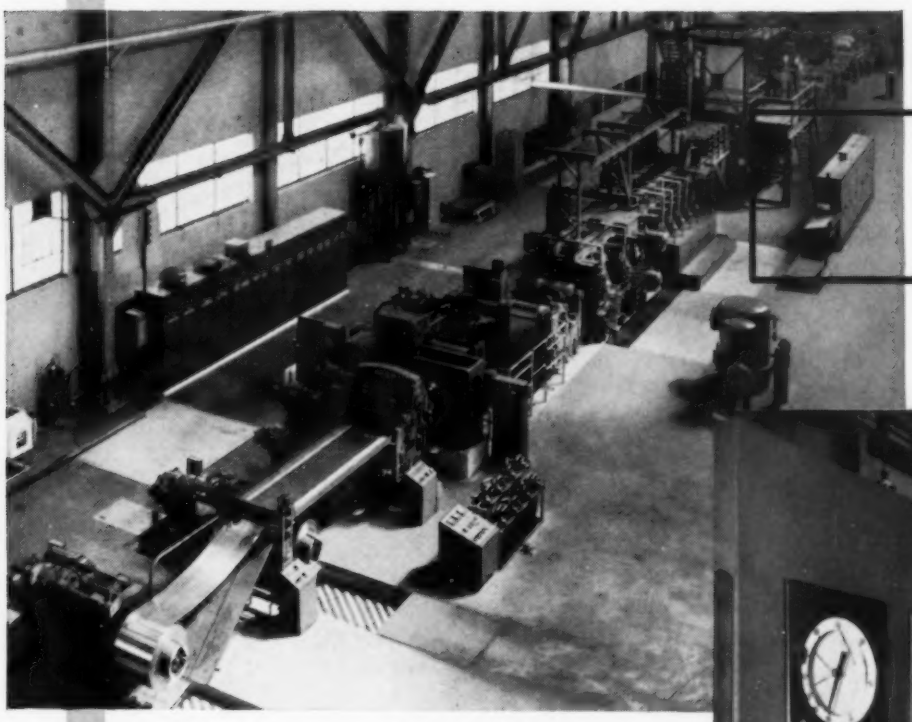
OAKITE SPECIALIZED INDUSTRIAL CLEANING MATERIALS • METHODS • SERVICE

MULTIPLE SAVINGS IN ELECTROLYTIC TINNING



BROWN INSTRUMENTATION IS THE *Plus-Factor*

. . . with *ElectroniK* Air-O-Line TEMPERATURE CONTROLLERS

Photos courtesy of The Steel Company of Canada, Limited.

Complete and integrated tin line control makes possible the attainment of greater production, with greater uniformity, at greater economy.

And the use of *ElectroniK* Potentiometers, with *Air-O-Line* Control, is your best insurance for constant and continuous achievement of all three goals.

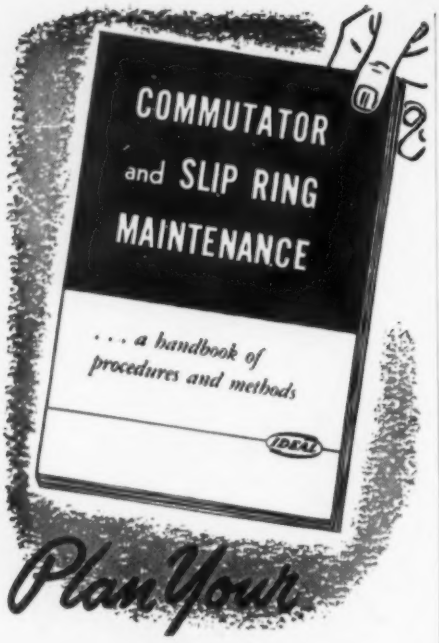
Typical is the installation pictured above, where multiple savings are effected day after day . . . through non-porous and even spread of metal, high operating speeds, less expenditure of power, and reduction in use of caustic. Accurate, precise control is afforded for the temperature of electrolyte, alkali, acid and quench . . . plus the level of the electrolyte in the main circulating tank.

A similar control system can be engineered to your tin line requirements. Call in our local representative for a detailed discussion today.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4464 Wayne Ave., Philadelphia 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS



MAINTENANCE PROGRAM *with this New* FREE HANDBOOK

The Commutator and Slip Ring Maintenance methods and procedures described have been proven over many years in hundreds of operations. They are based upon conclusive evidence compiled by well-known authorities. Concise, practical information tells everything you need to know about scores of commutator and slip-ring problems:

- **Commutator and slip ring troubles and how to correct them**
- **Brush maintenance and operating procedure**
- **General maintenance procedure**
- **Condensed data on IDEAL commutator and slip ring maintenance products**

Dozens of illustrations and diagrams show operations described. Every operating and maintenance man should have this guide to better, more efficient, lower cost maintenance. Mail coupon for your free copy.

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Please send me your free handbook on commutator and slip ring maintenance.

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CITY_____ ZONE____ STATE_____

passes through a spread coating unit; the top layer is a clear 2 mil film under which is the pigmented luminescent layer, and then base coats. After the various coatings are applied, the 36 in. wide fabric is cut to usable roll 4 in. wide. The adhesive is protected while not in use by covering which is easily stripped off.

ONE TON TRUCK

▲ A one-ton truck modeled and equipped for fast hauls of either short or long lengths is introduced by Gar-Bro Manufacturing Co. It has standard automotive drive with Ross steering assembly and Borg-Warner transmission and clutch. High, second, low and reverse speeds are controlled by one gear shift lever. Driver sits in elevated rear seat facing the load. In steering the front wheels turn as in passenger cars, said to effect readier and safer turns at sharp corners, around posts and in all kinds of aisle obstructions. Narrow aisle use is a feature as it has a turning radius of 8 ft.

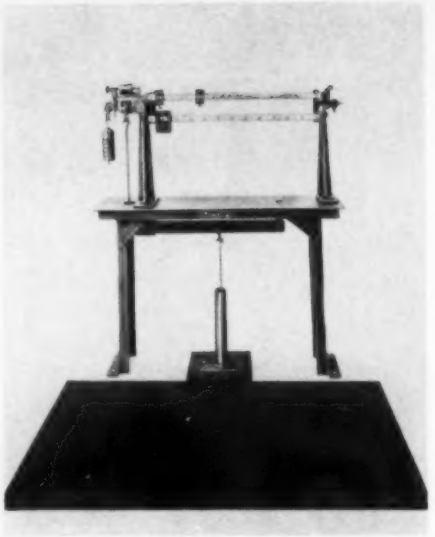
According to the manufacturer the truck is designed as a carrier vehicle and towing tractor, reducing costs per haul as compared to more costly fork truck operation. The unit is compact with low 20 in. bed, 4 ft wide, 5½ ft bed length. Weight is 964 lb. Speeds are 20 mph, high; 12 mph, second; 6.4 mph low or reverse. Drawbar capacity allows for a pull of 4000 to 6000 lb.

PLATFORM BEAM SCALE

▲ A new platform beam scale designed for fast accurate low-cost industrial weighing applications has been announced by Yale & Towne Manufacturing Co., Philadelphia division.

Called the "Load King," the new Yale scale is designed primarily for heavy-duty industrial applications where "shock-loading" is the rule. The lever system in the platform is all-steel as are other key parts. No wood is used throughout.

Poises on the main bar are mounted on roller bearings for rapid positioning. Other features of the new scale include a 100 per cent end loading platform that gives the same reading regardless of the location of the load on the platform. The platform, which is mounted on outboard bearings also absorbs the shock of



The new scale is designed for heavy-duty industrial applications.

moving loads without damage to the scale. It will not tip.

Pit requirements are only 11 in., saving considerable expenditure on excavation when the scale is installed. Available in self-contained and semi-self contained models, the new scale is built in capacities up to 6,400 lb. Platforms for the new scale range from 46 x 38 to 76 x 54 in.

MOTOR TRAINING KIT

▲ A new educational program designed to aid in the rapid training of industrial personnel in the selection and application of modern electric motor drives has been announced by the General Electric Co.

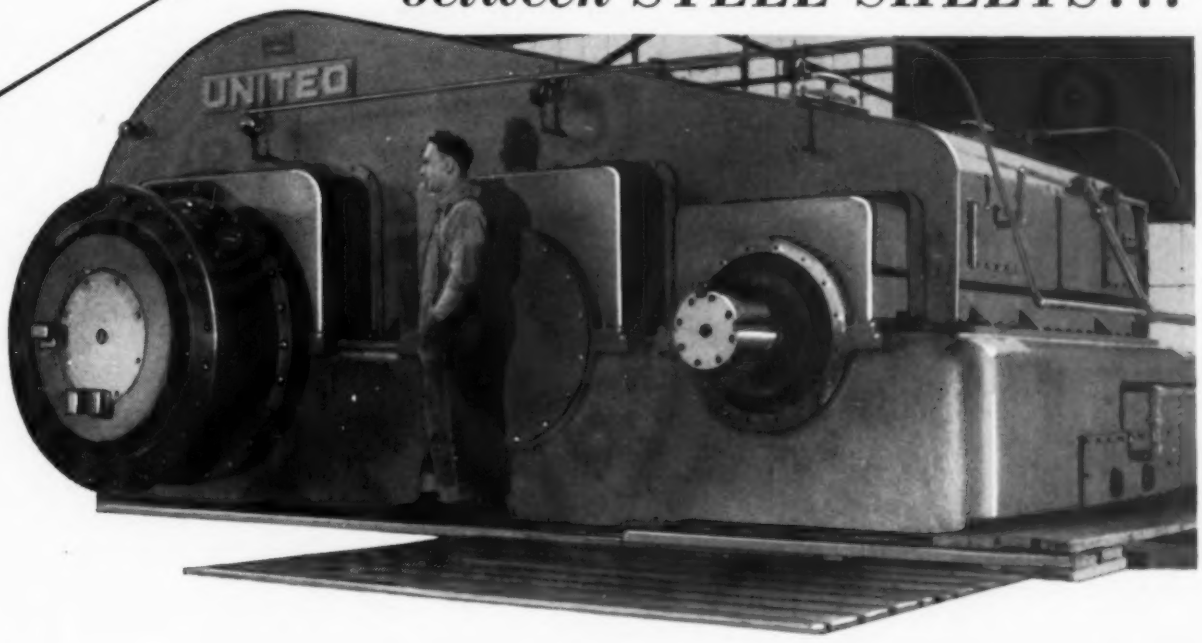
Fifteenth in the company's "More Power to America" series, the motor program is devoted to the task of quickly indoctrinating qualified personnel in the nation's factories as an aid to industrial mobilization.

The industrial motor program consists of a motor selection and appli-

The entire kit may be purchased for $100.

maintenance "SLEEPS"

between STEEL SHEETS...



United Engineering and Foundry Company's 66-inch, 4-high mills are recognized for top-production with high-working loads, plus a minimum of maintenance requirements.

Yes—maintenance *sleeps* on the job. Thanks in part to these double-reduction drives . . . all of which are completely SKF-equipped. SKF spherical roller bearings eliminate concentration of shaft stresses and the tendency of outer rings to work in their seats—only one of many contributions by SKF towards such all 'round, outstanding mill performance.

Throughout industry, SKF is making maintenance a "sleeper" by helping engineers and designers to put the right bearing in the right place.

7203

8 REASONS WHY SKF IS PREFERRED BY ALL INDUSTRY

integrity
craftsmanship
metallurgy
tolerance control
surface finish
product uniformity
engineering service
field service

SKF

SKF INDUSTRIES, INC., PHILA. 32, PA.—*manufacturers of* SKF *and* HESS-BRIGHT *bearings*

cation course made up of nine 35-mm black-and-white slidefilms, student review booklets on each lesson, and an instructor's manual. Each film has a running time from 15 to 30 minutes, and is accompanied by a 16-in. sound recording of the script.

The student booklets are intended to be passed out for home review to those taking the course. They contain reprints of slidefilm scripts with key pictures, quick-review outlines, and sets of test questions.

Prepared to enable any competent engineer to teach the course, the 96-page instructor's manual includes complete instructions on how to plan and set up each lesson, projection information, and complete scripts and pictures for all nine slidefilms. It also contains questions and answers to accompany review frames attached to each film, references sources, and answers to questions contained in the student review booklets.

The program will be distributed to G-E district offices throughout the country for showings to interested groups. These will include users and potential users of electric motors, application engineers, power sales engineers, machinery manufacturers, designers, contractors, consulting engineers, and students.

The entire kit, consisting of the nine slidefilms, one instructor's manual, and ten copies each of the nine student booklets, is packaged in a luggage-type carrying case and may be purchased from General Electric for $100. Additional manuals and student booklets are available at nominal cost.

PROPULSION EQUIPMENT

▲ Propulsion equipment for the largest ore carrier ever built for Great Lakes service will be supplied the American Shipbuilding Co. by General Electric for the National Steel Corp.

The new 690 ft vessel, designed 12 ft longer than the Wilfred Sykes, at present the largest operating ore carrier on the Great Lakes, will be driven by one cross compound, double reduction turbine gear set having a normal rating of 7000 hp at 108 rpm. Design steam conditions will be 450 psig, 750 F with exhaust to a 29 in. vacuum.

In addition to the propulsion equipment, General Electric will also supply two 500 kw turbine generator sets for ship's service power.

Scheduled to be launched in the summer of 1952, the new carrier will transport ore from the Upper Great Lakes region to Lake Erie ports. Its loaded speed of about 16 mph will permit over 45 round trips per season. It is designed to carry 20,340 tons of ore and has a beam of 70 ft and a moulded depth of 37 ft.

The ship's keel is scheduled to be laid in August 1951.

MOTORIZED STRAPPER

▲ An electric motorized dispenser of ¾ in. and 1¼ in. heavy-duty steel strap has been developed by A. J. Gerrard & Co. Located in any convenient spot, it uncoils the strap along the floor so that when the desired length has been obtained the operator can cut it off with the manually operated shear. What was formerly a two-man operation becomes a one-man operation with the Gerrard 430 coil dispenser.

The dispenser is easily loaded by rolling coil of strap into the cradle and threading end of the strap through the dispenser. Positive chain drive is employed with 110 volt a-c motor. Special motors for special currents are also available.

This new dispenser is especially desirable for use in steel mills, steel warehouses, shipping docks, etc., where long lengths of strap are required.

This electric motorized strap dispenser saves manpower.

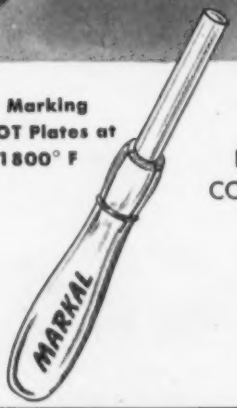
"15 Cents - - Saved us $15,000"

Says Steel Man

"Poor identification made with an inferior crayon burned off. In error, a soft iron slab went through the rolls which were set for a high carbon slab, causing a cobble and ruining the rolls, with a big loss of time. MARKAL PAINTSTIKS stopped this waste of money, time and production"

MARKAL PAINTSTIKS

Marking HOT Plates at 1800° F



are **PERMANENT** - *Weatherproof, Fadeproof*

Proved performance for HOT CASTINGS • STICKERS
COILS • PLATES • FORGINGS • ANNEALING • WELDING

Don't be misled! There's only one
MARKAL PAINTSTIK — *the Original!*

Write for FREE SAMPLE. We'll gladly help with any marking problem. Ask us.

MARKAL CO. 3087 W. Carroll Ave., • Chicago 12, Ill.
"Originators of Paintstiks"

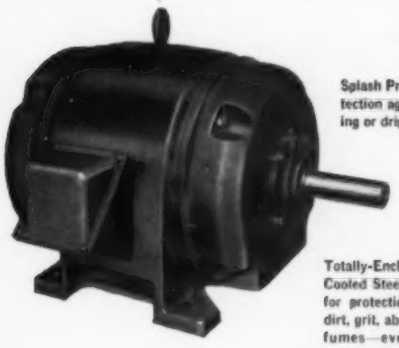
Wagner
ELECTRIC MOTORS
...the choice of leaders in industry

wherever motor hazards prevail...

GUARD PRODUCTION WITH Wagner Protected Motors

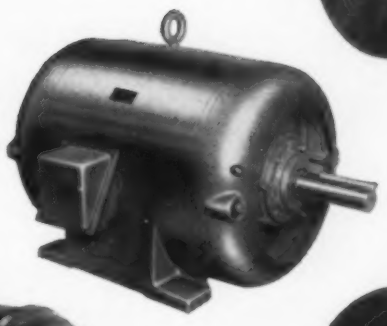
Do you use motors in locations where dirt, filings, moisture, splashing liquids, explosive gases, acid fumes, or other motor hazards prevail? If you do —no matter how severe the operating condition—Wagner can furnish the *right* motor for your purpose, adequately protected for specialized requirements.

Wagner protected type motors are known for completely dependable operation in their specific applications. They are backed by sixty years of motor building experience. Five protected-type Wagner Motors are shown below. Bulletin MU-185 gives full information . . . write for your copy.

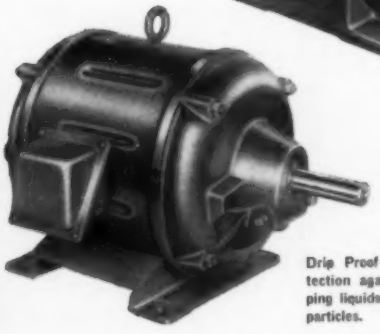


Splash Proof—for protection against splashing or dripping liquids.

Totally-Enclosed Fan-Cooled Steel Frame—for protection against dirt, grit, abrasives, or fumes—even in abnormal quantities.



Totally-Enclosed Fan-Cooled Cast Iron Frame—for protection against corrosion from fumes or moisture.



Drip Proof—for protection against dripping liquids or falling particles.

Explosion Proof—for complete protection in hazardous atmospheres.

Wagner Electric Corporation
1891 WE 1951

M51-10

WAGNER ELECTRIC CORPORATION
6483 Plymouth Ave., St. Louis 14, Mo., U.S.A.

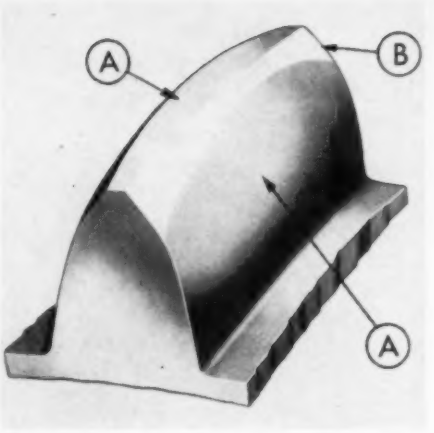
ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS — AIR AND HYDRAULIC

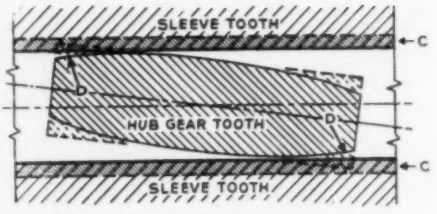
BRANCHES IN 31 PRINCIPAL CITIES

FLEXIBLE COUPLING

▲ Special tooth design increases load capacity and reduces backlash in new "Amerigear" flexible couplings, now offered by American Flexible Coupling Co. External teeth of the coupling hub gears are crowned at contacting surfaces, indicated by 'A' in the diagram, and are chamfered at 'B.' This reduces the clearances required and therefore reduces backlash, by the amount as shown by 'C.' It also prevents high stress at the tooth-end 'D', the weakest part of the tooth. Full contact is made along the strong side areas of the tooth.

The chamfer, an exclusive feature, prevents the edge of the hub teeth from striking filets at the root of the internal teeth or splines of the sleeve, so low clearance can be maintained while there is full contact along the side areas of the teeth. These features improve wear characteristics of the coupling, and permit unusual amounts of shaft misalignment, while reducing backlash to a minimum previously unattainable. The improved

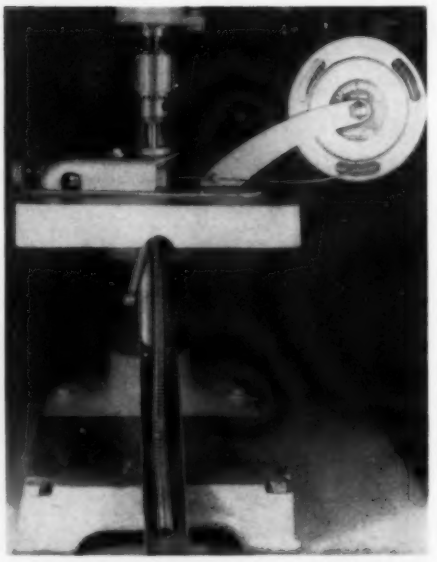




coupling is furnished in horsepower capacities from 2.1 hp to 4100 hp per 100 rpm, with corresponding maximum shaft speeds from 12,000 rpm to 1250 rpm.

SPRING WINDER

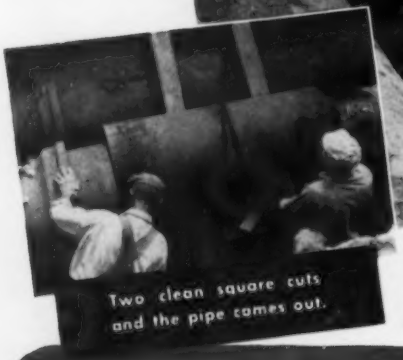
▲ Springs may be wound at high speed on any ½-in. drillpress, by use of Cycloid Corp.'s "Spring-Master." It takes wire from 6 to 28 gage. The outside diameter of the finished springs can be varied from 3/16 to 5/8 in. The pitch of compression springs



may be varied while the machine is running. The length is governed by the length of the wire used. One inexperienced operator can easily run two or more machines.

WACHS NATIONAL PIPE SAW

Tough Cuts MADE EASY



MAKE FAST AND ACCURATE CUTS ON 10" TO 48" CAST IRON AND STEEL MAINS UNDER THE MOST DIFFICULT CONDITIONS

- Minimum Pipe Line down time.
- Cuts under water in flooded ditches.
- No broken pipe, milled cut.
- Thor Air-Powered, no flames near pipe.
- Set-up time about 15 minutes.
- Portable — weighs only 265 lbs. Two men can carry and set up unit.
- Small excavation — only 16" clearance needed.
- One machine cuts all pipe sizes from 10" to 48".
- Only two adjustments necessary for size changes.

Many tough pipe cuts must be made during construction, for emergency repairs and for maintenance. This one portable machine will handle all your pipe cuts from 10" diameter and up. You will not only save time and labor, but you will get tight joints because of the square milled cut. The Wachs Pipe Saw also cuts cement lined pipe and makes beveled cuts on steel pipe. This machine often pays for itself on a single job.

Write today for descriptive folder and engineering data on this new labor saving saw.

THE E. H. WACHS COMPANY

Manufacturers of Engines, Valves and Machinery since 1883

1525 NORTH DAYTON STREET · CHICAGO 22, ILLINOIS

Publication Service...

APRIL, 1951

(1) Colloidal Graphite

A new bulletin on "Colloidal Graphite as a Parting Compound" has been released. The publication describes how colloidal graphite dispersions are used profitably in industrial plants. Because it is a unique lubricant that is unaffected by heat up to 3500 F in inert atmospheres, "dag" colloidal graphite is widely used to prevent sticking, corrosion, galling, and "freezing" of parts. It is particularly effective on the screw threads of bolts and nuts. Treated threads can be drawn up tighter and with less effort than those to which no "dag" colloidal graphite has been applied. (427). Acheson Colloids Corp.

(2) Specifications folder

A new Standard Specifications Folder containing complete data on fork lift trucks, tractors and electric pallet trucks, has just been made available. The folder gives such information as capacities, load centers, lift heights, weights, dimensions, turning radii, speeds of travel, etc. Easy to read and study, the folder is an excellent example of conciseness in giving factual information which busy executives need to see when thinking about equipment to solve their materials handling problems. (F2). Towmotor Corp.

(3) Stud Welding

Detailed specifications and performance characteristics of two Nelwelder power units specifically designed to improve and extend the advantages of stud welding are described in a new 4-page bulletin just issued. One is a small compact power unit which gives stud welding performance equivalent to two conventional 400-ampere generators in parallel. It can be used to weld studs up to and including $\frac{5}{8}$ in. in diameter. The other is a battery unit with a self-contained automatic charging device which is operated from any 110-volt a-c convenience outlet. Especially useful in construction work where power required for operation of motor driven welding generators is not available, this unit welds studs up to $\frac{1}{2}$ in. and can be easily transported in trailer units of various types. Nelson Stud Welding division, Morton Gregory Corp.

You Can Obtain...

... any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

(4) One-Piece Fintubes

A new bulletin describes the construction of integral extended surface fintubes; lists the range of sizes and the materials in which they are available; illustrates the wide variety of heating and cooling applications in which they are used, and gives three pages of extremely helpful engineering data, including design curves and a tabulation showing the comparative outside surface areas provided by different sizes of bare pipe or tubing, and longitudinally finned pipe or tubing. (511) Brown Fintube Co.

(5) Cushioned Valves

A new bulletin fully describing a cushioned single-acting non-return valve is now available. Three different yoke assemblies on the elbow, angle and globe bodies are featured in detailed drawings, with a complete list of parts. The adaptability, testing, construction, installation, sequence of operation, servicing and specifications are fully described, along with tables showing general dimensions, approximate shipping weight, and general list of materials. (S-2). Golden-Anderson Valve Specialty Co.

(6) "RC" Flexible Couplings

A new folder on Link-Belt "RC" roller chain flexible shaft couplings has been published. Engineering information for proper application includes dimensions, weights, service factors and horsepower ratings. Detailed data are also given on two types of protective grease-retaining casings — Style R (spun metal revolving type) and Style P (plastic, revolving type). (2363). Link-Belt Co.

(7) Defense Production

A new and comprehensive bulletin on heating and heat treating equipment for defense production has just been issued. This new bulletin covers heating for forging as well as heat treatments to develop the required properties for the production of all kinds of ordinance material. Among the items covered in the bulletin are ammunition, guns, tanks, aircraft and ships. The production of engines, power transmission equipment, as well as tools and special parts, is also covered. (SC-150). Surface Combustion Corp.

(8) Hand Trucks

The most recent brochure in a series being issued is one covering "Floormaster" trucks. This new bulletin illustrates and describes the standard line of 2 wheel and 4 wheel trucks commonly used. A large number of illustrations are devoted to trucks that vary only slightly from standard to those that are completely special. (29). Lewis-Shepard Products, Inc.

(9) Motor Starters

Motor starters for 2300 to 5000-volt squirrel cage, wound rotor, synchronous and multi-speed motors are described in a new bulletin recently released. The starters are built for full voltage or reduced voltage, reversing or non-reversing, with plugging, dynamic braking and multi-speed features. Ratings are up to 2500 hp at 5000 volts. The contactors (air break or oil immersed), protective devices, meters, and relays are engineered and assembled in an easy to install steel cabinet. The air break contactor, particularly adaptable for applications requiring frequent starting, inching, reversing, plugging or dynamic braking is described in detail in another late bulletin. For most applications, this contactor will fit in the same size starter cubicle as used for oil

immersed contactors. The oil immersed contactor is designed to withstand stresses of frequent starting and stopping service and can be used in dust laden atmospheres and in other locations where atmospheric contamination would interfere with the proper operation of air contactors. Copies of the bulletins, "Type H Motor Starters" (14B6410A) and "Type 256 High Voltage Air Break Contactor," (14B7303) are available. Allis-Chalmers Manufacturing Co.

(10) Controlled Atmosphere

To show how heat-treaters can now have full control not only over temperature and time, but over furnace atmosphere in such diverse applications as hardening, annealing, normalizing, carbon restoration, and carburizing to controlled surface carbon content, an illustrated catalog section has been published. It describes the new Series H "Homocarb" furnace equipment, with recently-developed "Microcarb" control, which continuously and automatically regulates carbon content of the atmosphere. This publication describes how the heat-treater can automatically control the carbon content of the surface of the steel being treated to any selected point in the range of 0.15 to 1.15 per cent carbon. A center-spread illustration displays the complete Series H equipment. (Cat. T-623, Sec. 1) Leeds & Northrup Co.

(11) Dust and Fume Control

"American Dustube Dust and Fume Collectors in the Mining and Metallurgical Industries" is the title of a new illustrated bulletin now available. The bulletin describes the operation of cloth tube type collectors employed in recovering values in gases from roasters, sintering machines, induction furnaces, etc. The observation is made that a wide selection of filter fabrics, including new synthetics, has increased the scope of cloth filtration so that hot and/or corrosive gases may be efficiently and economically handled. It is reported that uniform recoveries in excess of 99 per cent by weight, of the fume entering the collector are being effected, and the collected material can be reprocessed without dewatering, filtering, or drying. (282). American Wheelabrator and Equipment Corp.

(12) Thermocouple Buyer's Guide

Just published is a new edition of a thermocouple and pyrometer accessories manual, listing many additional items and containing new data on the proper application and use of thermocouples. The new 56-page bulletin contains a well illustrated catalog of hundreds of pyrometer supply items, including assembled thermocouples, thermocouple wires, extension wires, protection tubes, insulators, and accessories for the full range of industrial pyrometer applications. New technical information and installation sketches have been added to the "Users' Manual" section, which contains engineering data on modern practices in pyrometry. Also included are tables of calibration data for the commonly-used base metal and rare metal thermocouples. (P1238). Bristol Co.

(13) Vertical Cable Support

Product data is available on a new type of vertical cable support engineered to provide for an extension of rigid conduit or flexible conduit. According to the literature, typical installation would support the cables as they rise vertically in rigid conduit, and before they are continued in flexible conduit to some large rotating machine. The design of the fitting locks the wedging inserts into position, thus insuring trouble-free service. The series includes a cable support that enables the cables to be rigidly clamped and supported, and at the same time provides a terminal end to be sealed with compound. (G-2-51). Adalet Manufacturing Co.

(14) Motors and Generators

A 19-page booklet (B-4595) describing the new "Life-Line" type SK d-c motors and generators is available. It shows how the new design uses rolled steel frames, heavy steel brackets, steel angle feet, and prelubricated double-sealed ball bearings to provide added strength and long life without outages. The booklet pictures and discusses the use of cast brass brushholders, stainless steel springs, and Melamine Moldarta molded rocker rings for maximum corrosion resistance in the brushholder assembly. It describes the unit construction of field coils for ease of replacement. Tufvar insulated conductors are used, the booklet points out, in the armature for toughness, flexibility, and protection against heat, moisture, dirt, and vibration. Also shown is the unique construction of the end turns, which causes a fan effect that provides a constant flow of air through the motor, preventing localized heating. (B-4595). Westinghouse Electric Corp.

(15) Materials Handling Equipment

A new comprehensive 44-page catalog of materials handling equipment has been released. Subjects covered include a general description and application data on Yale's gas and electric fork lift trucks, motorized hand trucks, hand lift trucks, and hand and electric hoists. One particularly interesting section describes the various attachments available for Yale industrial trucks that give them versatility in jobs performed. (P-602 Rev.). Yale & Towne Manufacturing Co., Philadelphia Division.

(16) Industrial Cleaning Operations

A very useful booklet on machinery cleaning, rust-inhibiting and the removal of rust-preventive coatings is available. The information in this booklet is based on actual industrial plant operations and illustrates efficient methods and processes. A few of the specific operations featured are the cleaning of stationary machinery, motors, bearings and other machine parts. Several rust-inhibiting, and dual cleaning with rust-inhibiting operations are illustrated. A very timely bulletin on the depreservation of machinery or the removal of rust-preventive coatings from machinery, equipment and tools is included for industries now expanding and retooling. The booklet also contains a two page leaflet "Actusol Applications Analyzer" on the general applications of "Actusol," emulsifiable solvent cleaning compound. (1864). Du Bois Co.

(17) Brushing Catalog

A new 76-page brushing catalog, designed to simplify selection of the best brush for the individual job, has just been issued. The informative new publication contains many innovations, including a three-page digest of the origin of

Osborn brush materials from many parts of the world, a three-page section devoted to factors involved in selecting the right brush for specific jobs, and including operating equipment requirements, brush characteristics, operating conditions, surface speeds and other helpful information regarding brush usage. Many of the photographs illustrate the various types of brushes in actual use, thus giving readers of the catalog the advantage of seeing various types of brushing setups as well as photographs of the brushes in use. In addition to a quick reference index on the cover page, the catalog contains a numerical index by brush numbers as well as the conventional alphabetical index. (210). Osborn Manufacturing Co.

(18) Solvent Cleaning Facts

How solvent detergents provide outstanding benefits in hundreds of industrial cleaning applications is discussed in a 24-page illustrated booklet recently issued. The booklet reports upon the many classifications of cleaning in which solvent detergents are being successfully used today to perform such typical tasks, for example, as: removing oily films, smuts, cutting, drawing and stamping compounds from steel in metal fabrication processes; removing carbonized oil and grease deposits encountered in the repair and maintenance of transportation facilities; to make cleaning more practical by precleaning to remove extra-heavy deposits in a preliminary operation, especially applicable where metal parts are thickly coated with oils, grease and solid-particle soils; and to provide temporary rust protection to metal surfaces after cleaning. The booklet gives specific applications of solvent detergents in metalworking plants and lists these advantages. (F8143). Oakite Products, Inc.

(19) Commutator Maintenance Handbook

A handbook entitled "Commutator and Slip Ring Maintenance" is available to you. The book tells of procedures and methods developed by independent authorities on commutator and slip ring maintenance. It shows how to protect against shut-downs and high cost overhauls resulting from commutator and slip ring failure. Ideal Industries, Inc.

(20) Telemetering

A new folder on telemetering has just been published. The folder contains information on the use of the company's "Metameter" telemeter for remote measurement and automatic control of variables over distances ranging from a few feet to many miles. A large number of typical installations of these telemeters at gas companies, water plants, pipe line companies, electric utilities, processing and manufacturing plants throughout the country are illustrated and described. Among the applications shown are the remote measurement and control of temperatures, pressures, rates of flow, level of liquids, motion, and various electrical quantities. (DM029) Bristol Co.

(21) Motor Changeovers

A book of machining tabulations is available to you. The tabulation booklet contains sheets on the following types of motors; General Electric mill and crane type motors, Westinghouse mill and crane type motors, and Crocker-Wheeler mill motors. Roller bearing and sleeve bearing armatures are interchangeable within the frames after frame alterations are made to accept the motor changeover. These tabulations contain the application of Van Pelt maintenance series railway roller bearings to motor changeovers. Van Pelt Electric Co.

(22) Insulating Firebrick

A folder has just been published entitled "JM-3000 Insulating Fire Brick." The catalog presents the economic advantages, industrial applications and refractory properties of this product, the first insulating fire brick for sustained use at 3000 F. Physical and thermal characteristics are given in table form. An illustrated description highlights the use of these insulating fire brick in the construction of a slot type forging furnace. The folder also contains summarized information on accessory materials and other insulating brick made by Johns-Manville.

(23) Space Heating

Publication is announced of a bulletin describing Dravo "Counterflo" direct fired space heaters in a range of gas or oil fired models with outputs from 400,000 to 2,000,000 Btu per hour. High lighted in the bulletin is a comparison chart showing that steel requirements for the installation of these heaters is substantially less than that of other commonly used systems. In most cases, the bulletin points out, steel needs for heating systems can be reduced 50 to 70 per cent through the use of direct-fired warm air heaters. (526). Dravo Corp.

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50	ADALET MANUFACTURING CO.		Supplement available on cable seals.
51	AIR REDUCTION SALES CO.	FOLDER ADR-64	Describes hardfacing applications.
52	ASKANIA REGULATOR CO.	BULLETIN 115	Askania controls.
53	BAILEY METER CO.	BULLETIN 230-C	Electronic resistance thermometers.
54	BEDFORD FOUNDRY AND MACHINE CO.		Bedford cranes.
55	BRISTOL CO.	BULLETIN M1700	Bristol Metameter telemeter.
56	BROOKS OIL CO.		Leadolene Klingfast.
57	BROWNING AND CO., INC., VICTOR R.	BULLETIN "E"	Mill type cranes.
58	CITIES SERVICE OIL CO.		Combustion control for industry.
59	CLARK CONTROLLER CO.	BULLETIN 9235	A-c crane hoist control.
60	COLUMBIA ELECTRIC MANUFACTURING CO.		Motor generators.
61	CROUSE-HINDS CO.	BULLETIN 2565	Floodlights.
62	CUNNINGHAM CO., M. E.	BULLETIN J-547	"Safety" tag embossing and tagging outfit.
63	ELECTRIC CONTROLLER AND MFG. CO.	BULLETIN 942	Tab-weld plate resistors.
64	ELECTRIC SERVICE MFG. CO.		Keystone insulators.
65	ELECTRIC STORAGE BATTERY CO.	FORM 5161	Exide-Ironclad batteries.
66	ELLIOTT CO., CROCKER-WHEELER DIVISION		C-W "Sealedpower" motor.
67	FARREL-BIRMINGHAM CO., INC.	BULLETIN 115	Heavy-duty roll grinder.
68	GENERAL ELECTRIC CO.	BULLETINS GEC-471 AND GEC-485	X-ray thickness gage.
69	GENERAL ELECTRIC CO.	BULLETIN GEA-5409	G-E "limitamp."
70	GULF OIL CORP.		Gulf E. P. lubricants.
71	HAYS CORP.	BULLETINS 49-750 AND 49-605	Instruments and controls.
72	HEYL AND PATTERSON, INC.	BULLETIN 2-50-KCU	H&P Kinney car unloader.
73	HOMESTEAD VALVE MFG. CO.	CATALOG 39-5	"Self-seald" lubricated valves.
74	HUNT AND SON, INC., C. B.	DATA SHEET 3402	High pressure hydraulic strainers.
75	HUNT AND SON, INC., C. B.	BULLETIN 104-C	Valve couplings.
76	IDEAL INDUSTRIES, INC.		Handbook on commutator and slip ring maintenance.
77	INDUSTRIAL GEAR MFG. CO.		Pictorial trip through gear plant.
78	JONES FOUNDRY AND MACHINE CO., W. A.	BULLETIN 68	Selection tables and dimensions.
79	KOPPERS CO., INC.		Flexible couplings.
80	LESLIE CO.	BULLETIN 461A	Reducing valves.
81	LINTERN CORP.	BULLETIN AC 4912	Lintern "Airerectifier."
82	LOVEJOY FLEXIBLE COUPLING CO.		Flexible couplings.
83	MAGOR CAR CORP.	BULLETIN DS-102	Magor air dump cars.
84	MARKAL CO.		Paintstik samples.
85	MEDART CO.		Centerless bar turner.
86	OAKITE PRODUCTS, INC.	FOLDER F7642	Advantages of the Oakite "CrysCoat" process.
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88	RELIANCE ELECTRIC AND ENGINEERING CO.	BULLETIN C-2001	D-c motor selection.
89	RUST-OLEUM CORP.		Rust preventives.
90	SPRAYING SYSTEMS CO.	CATALOG 22 AND DATA SHEET 3997	Descaling nozzles.
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95	WACHS CO., E. H.		Wachs pipe saw.
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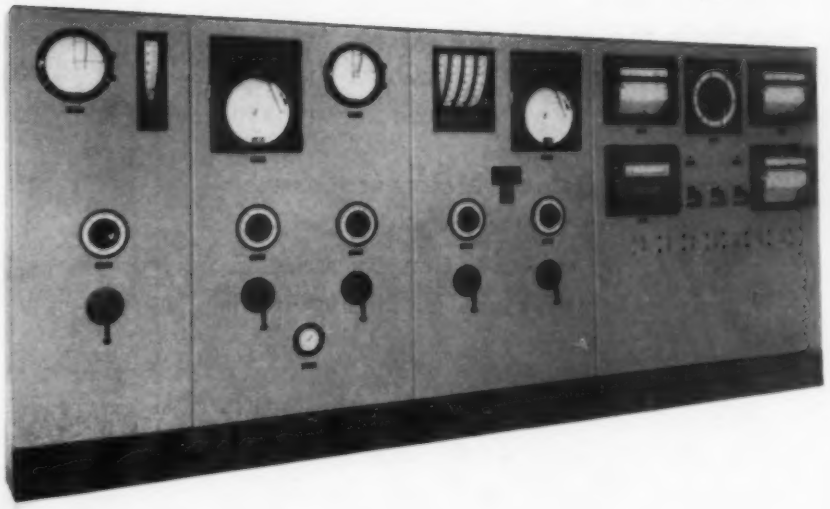

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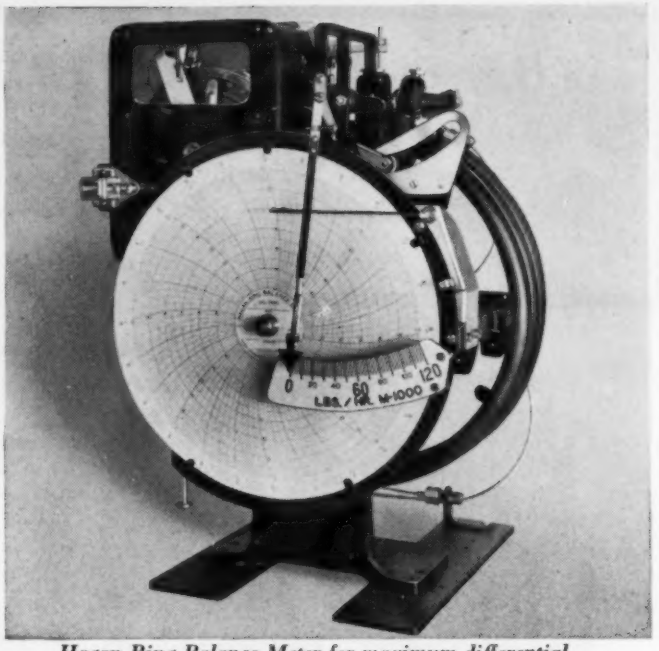

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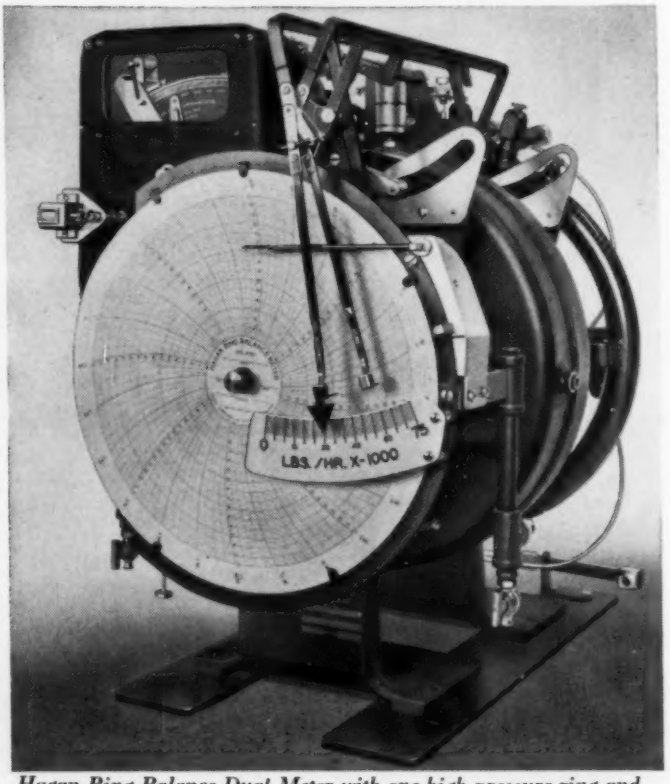

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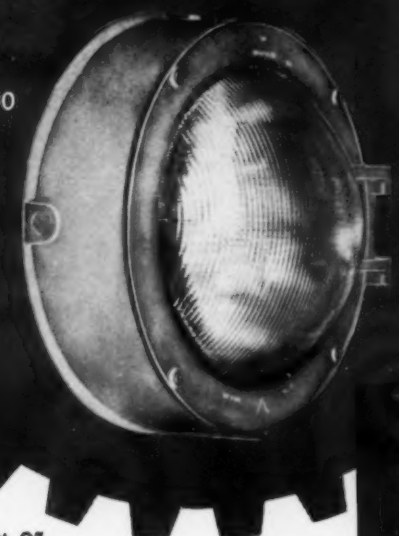

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▲ **Oxygen Cutting,** by Slottman and Roper, is of particular interest, since the widescale use of oxygen cutting in the production effort of World War II firmly established this process as the standard industrial method for shaping ferrous metal parts for fabrication. This book provides the metal working industry with a comprehensive and authoritative manual of practical oxygen cutting techniques, as well as a summary of our present-day knowledge of the subject. In addition to fundamental information on the action of the cutting jet and the mechanism of the process, the book includes extensive discussions of the many uses to which oxygen cutting may be applied, and presents interesting historical background material.

Special chapters are devoted to the effects of oxygen purity, metal temperature, and alloying elements on the cutting action; the effects of oxygen cutting on ferrous alloys; plant facilities; oxygen cutting equipment; the operation and use of the oxygen lance; hand and machine cutting; electronic tracing devices; multiple and stack cutting; and underwater cutting, to mention several.

Oxygen Cutting is priced at $6.50 and may be obtained from McGraw-Hill Book Information Service, 327 W. 41st Street, New York 18, N. Y., 6 × 9 in., clothbound, 407 pp.

▲**"The Behavior of Engineering Metals,"** by H. W. Gillett, 395 pp, 6 x 9 in., price $6.50, is a new materials book which has just been published by John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. With the present emphasis on material substitutes and material shortages, this book is particularly valuable to men who must specify materials at the present time. The book gives the viewpoint of the metallurgist for those who have not specialized in this field. The book covers the behavior of materials, rather than the theories which may help explain behavior. The principal commercial metals and alloys are covered, as well as the special considerations which may influence the selection of metals and alloys.

▲**"Fuels and Combustion Handbook,"** edited by Allen J. Johnson and George H. Auth, has recently been published by McGraw-Hill Book

(*Please turn to page 214*)

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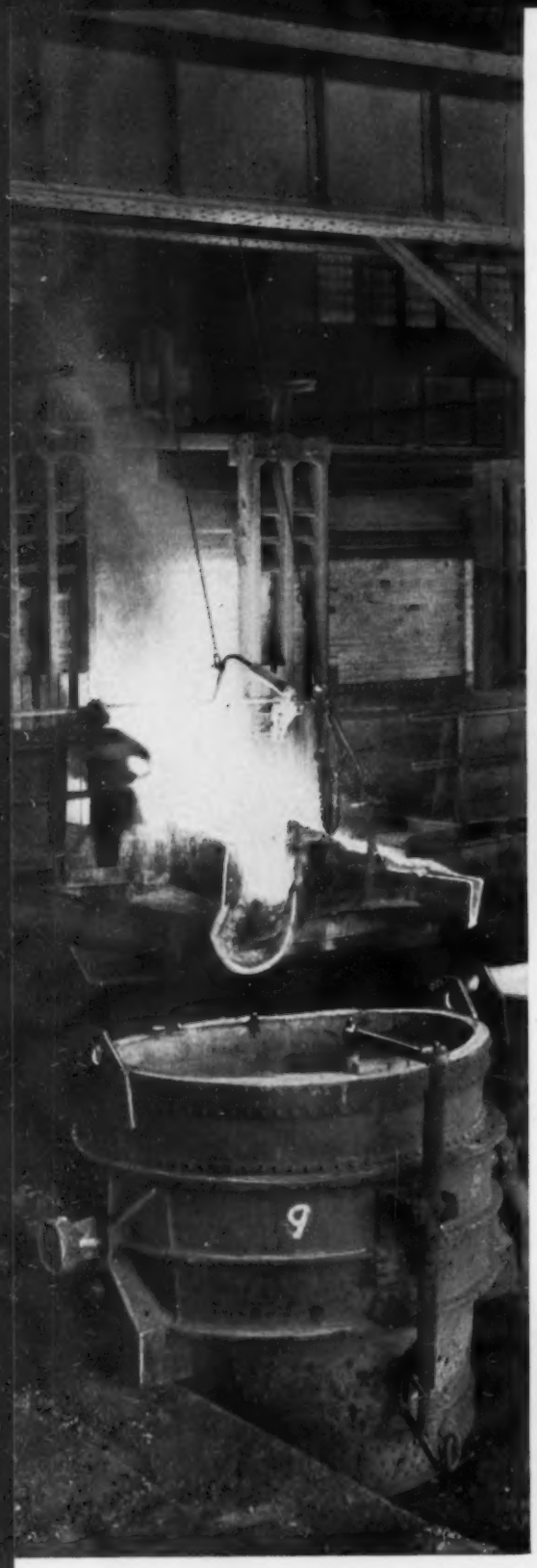

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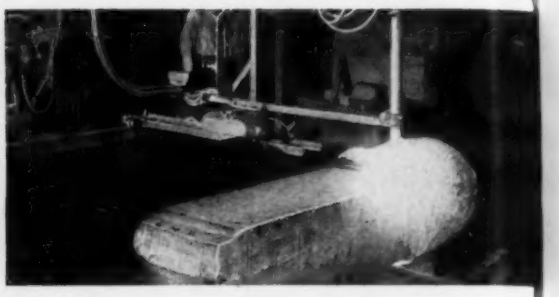

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The deseaming blowpipe, equipped with the OXWELD starting-rod feed, has reduced conditioning costs more than 50 per cent.

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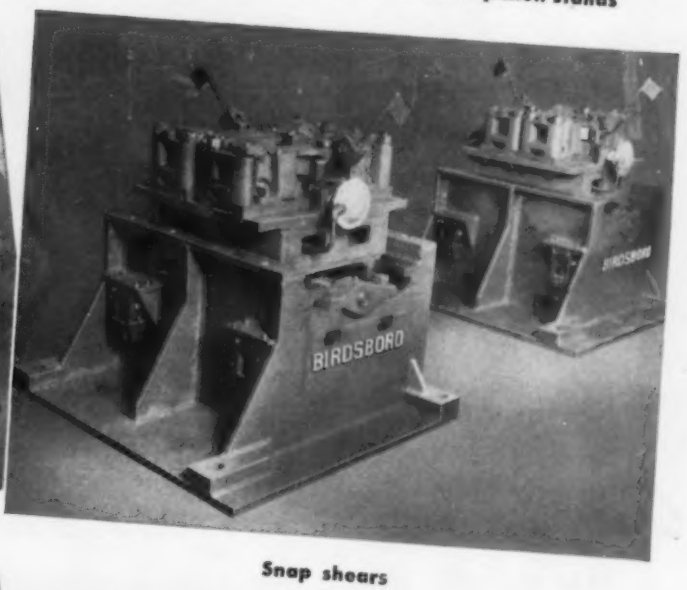

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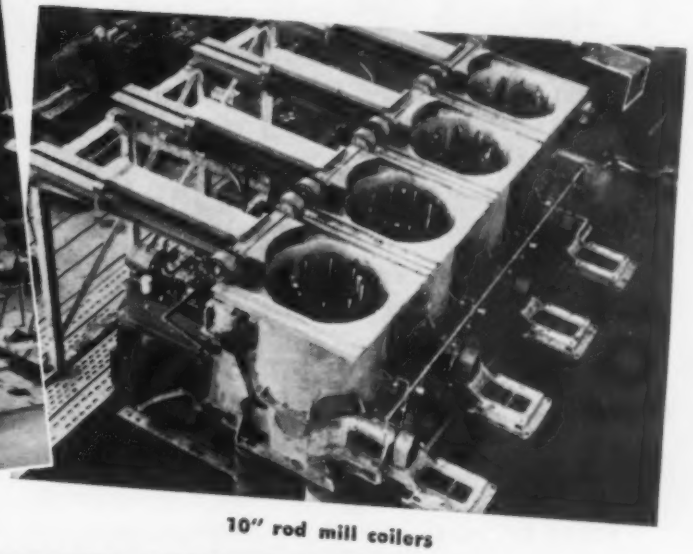

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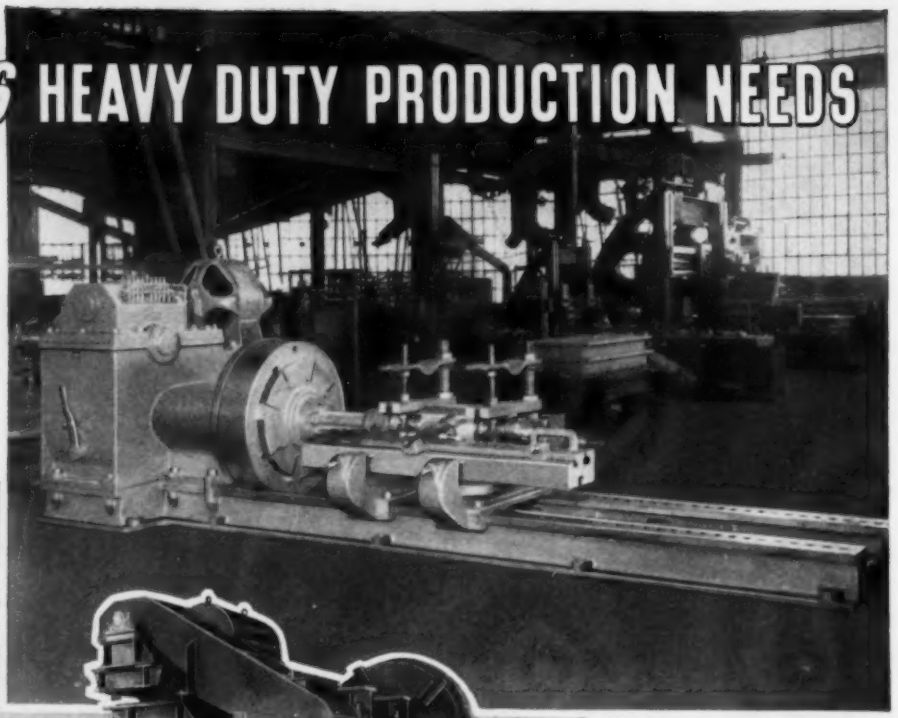

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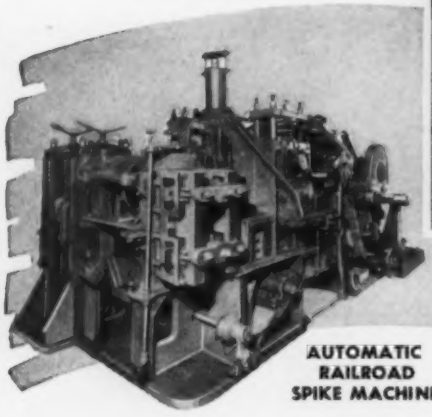

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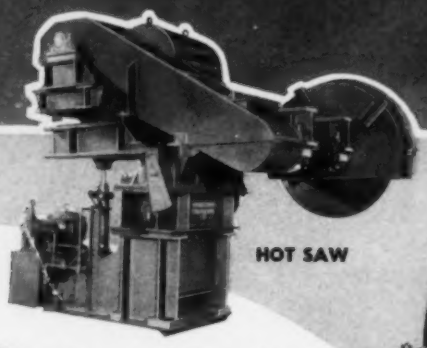
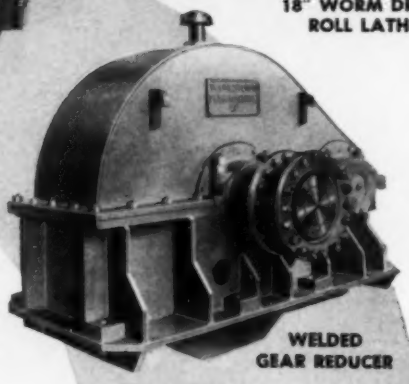


HOT SAW



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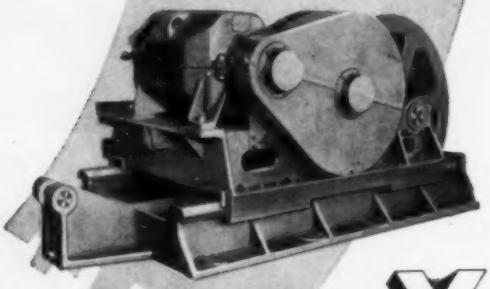

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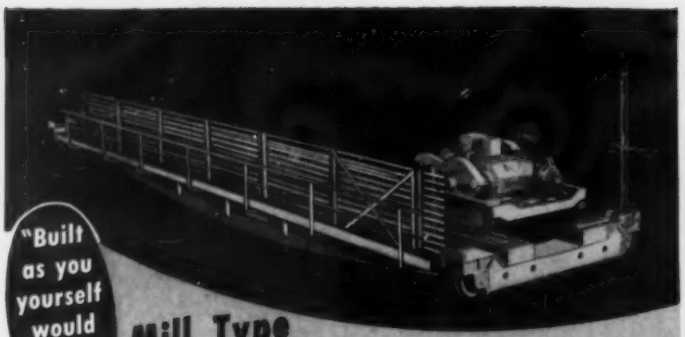

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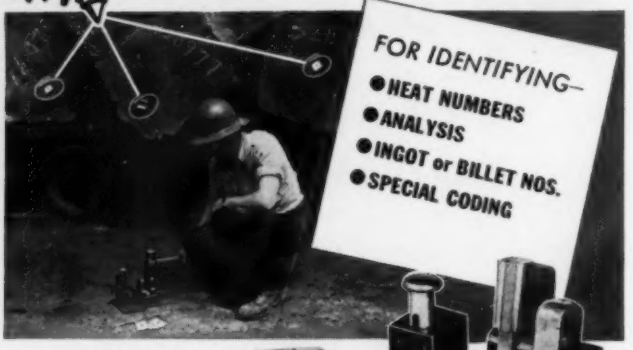

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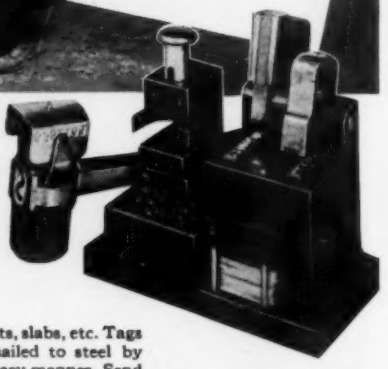

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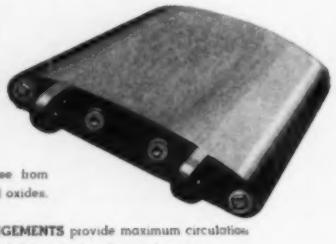

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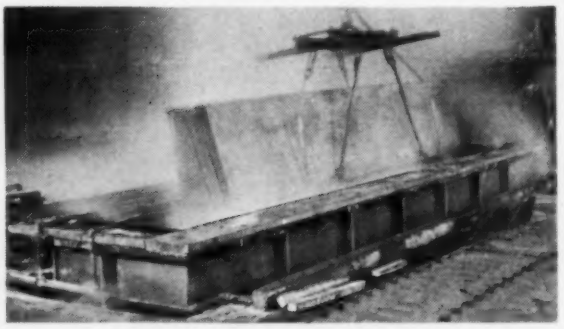

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Detroit and Buffalo territories now available. Write qualifications and personal history in first letter to: The Ramite Co. Div. of The S. Obermayer Co., 2563 W. 18th Street, Chicago 8, Illinois.

Book Reviews

(*Continued from page 204*)

Co., 330 W. 42nd Street, New York, N. Y., 915 pp, 6 x 9 in., price $12.50. This book is a practical handbook which will be of particular interest to the engineers and combustion men working in the iron and steel industry. The book gives data on the properties, characteristics, and uses of all solid, liquid and gaseous fuels, the basic types of combustion of these fuels, and the operation and use of combustion equipment. The book describes the factors involved in the selection and purchase of fuels, fuel handling and storage, determination of heat balances, smoke prevention and draft requirements. The book makes wide use of alignment charts and substitutes tables and graphs for formulas.

▲**"Engineering Hydraulics,"** edited by Hunter Rouse, is the first American reference book to present a science of hydraulics in a complete manner. This book deals primarily with the principles, rather than with the applications of the science. This book, which has been written by thirteen authors, each one handling a section of the book, has been published by John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., and consists of 1039 pages, 6 x 9 in., price $15.00. Although the book has been written by a number of different authors, each of whom is a specialist in his field, careful editing has correlated the various chapters into a logical development of the subject matter from the earliest fundamentals to their final application. Of particular interest to plant engineers are the chapters on flow measurement, steady flow in pipe and conduit and hydraulic machinery.

Torrington 12-Roll Tube Straighteners on the job for American Brass at Kenosha, Wis.

American Brass installs 4 Torrington Straighteners in new Kenosha Tube Mill

As part of a "continuing program of improving plant facilities and equipment", the American Brass Company has installed 4 Torrington 12-Roll Tube Straighteners and other Torrington machinery in the recently completed tube mill at Kenosha, Wisconsin.

FEATURES OF TORRINGTON 12-ROLL HIGH-SPEED STRAIGHTENERS

1. Versatile: handles round, hexagon, square or rectangular rods and tubes.
2. High-speed: processes up to 700 feet per minute.
3. Fast set-up and adjustment: rolls are overhung, without outboard bearings.
4. Long-life, trouble-free construction: all gears run in oil and are totally enclosed.
5. Anti-friction bearings throughout.
6. Flexible: has easily-adjustable power drive.
7. Positive action: all rolls are power-driven.

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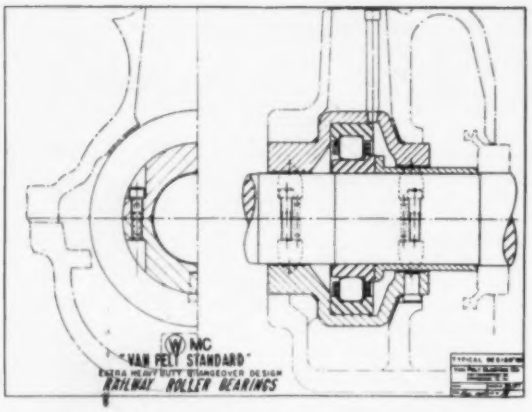
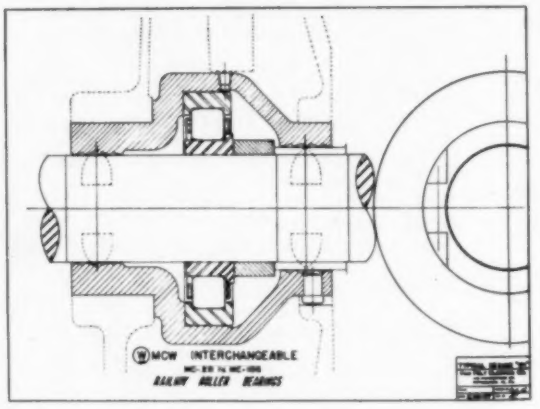
★ For Westinghouse Type MC Mill Motor Bearing Changeovers

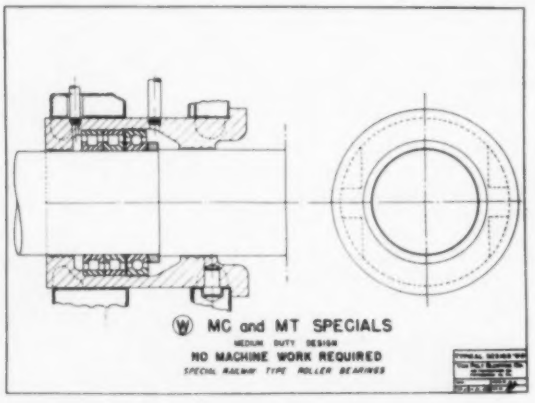


"VAN PELT STANDARD" EXTRA HEAVY DUTY DESIGN

This design, the very best possible, permits full interchangeability with the old sleeve bearing armature in the frame adapted for the Roller Bearing Cartridge. It provides extreme life for least cost.



INTERCHANGEABLE HEAVY DUTY DESIGN—Fully interchangeable with the original Westinghouse roller bearing frame as well as their roller bearing conversion design. However, this design does eliminate interchangeability with the old sleeve bearing armatures.



SPECIAL MEDIUM DUTY DESIGN—When the frame bores are within standard tolerances, the units fit exactly in the space of the old sleeve bearing shell. It provides medium duty capacity, but very satisfactory bearing life.

Machining tabulations for these and other types of mill and crane motors are available from us upon request.

VAN PELT ELECTRIC CO.

105 FAHNESTOCK ROAD • PITTSBURGH 15, PA.

For worms and gears—in standard sets or to special requirements—or as worm-gear speed reducers, including the economical fan-cooled Speedaire unit—you can always depend on Cleveland.

High quality worms and gears to meet your needs

● You pay no more for Cleveland worms and gears—and yet, built into them are extra years of service and satisfaction.

Uniform, high quality has been an outstanding characteristic of Clevelands through 38 years—a generation devoted to the manufacture of fine worms and gears exclusively. Specifically, there are four ingredients of Cleveland quality:

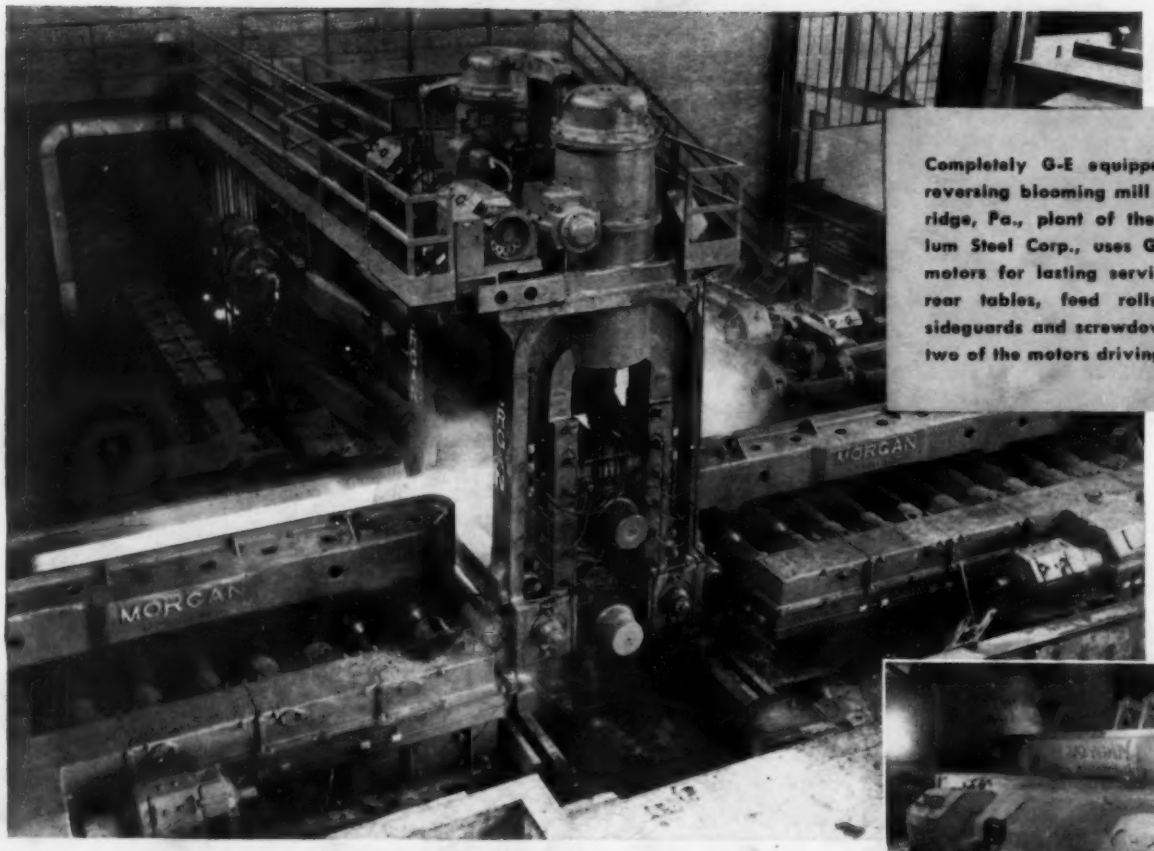
1. Correctness of design—design proved best by years of performance.
2. The finest of materials, selected after years of experience and research.
3. Modern machine tool equipment, in a modern plant kept up-to-date by a policy of continuous replacement.
4. Machinists and other production workers who are craftsmen, trained in precision work.

So whatever your need, consult Cleveland. Sales representatives in all major industrial centers are at your service, to help you select correct types and sizes and discuss any phase of your power transmission problems.

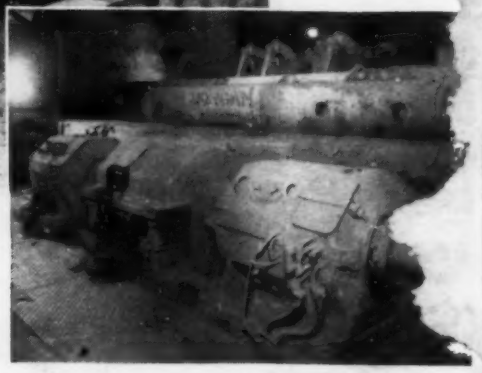
Write for the latest Cleveland catalog, indicating your requirements. The Cleveland Worm & Gear Company, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND
Worm Gear
Drives



Completely G-E equipped, this 40-inch reversing blooming mill at the Brackenridge, Pa., plant of the Allegheny Ludlum Steel Corp., uses G-E MD-600 mill motors for lasting service on front and rear tables, feed rolls, manipulators, sideguards and screwdowns. Inset shows two of the motors driving the front table.



OUTAGE TIME CUT

in 40" reversing blooming mill!

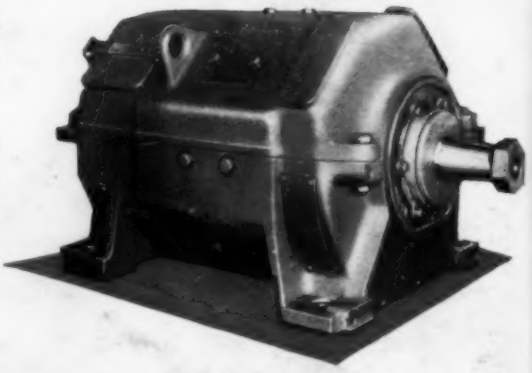
G-E d-c mill motors give day-in day-out dependability on essential auxiliaries

Here's why: Rugged construction throughout safeguards these G-E MD-600 mill motors against all kinds of steel-mill conditions. They're protected against heat of furnaces and hot metal—against mechanical shock and strain—against dirt, corrosive fumes and excessive moisture—against the effects of frequent starting, stopping and reversing. Motor life is longer, replacements fewer!

Further lengthening their service life is improved ventilation that dissipates up to 50 per cent more heat, plus mica, glass, and silicone resin insulation. Besides, compact design gives you more hp per frame size than in former types.

Here's more: G-E MD-600 d-c mill motors are available in standard mill ratings from 7½ to 200 hp to meet AISE specifications. For a detailed description of their many long-life features, write for Bulletin GEA-4654. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

MD-600 MILL MOTORS



GENERAL ELECTRIC

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